Petroleum
REFINER
FOR THE HYDROCARBON PROCESSING INDUSTRY

FEBRUARY 1961

A SPECIAL REPORT

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YARWAY Y news briefs

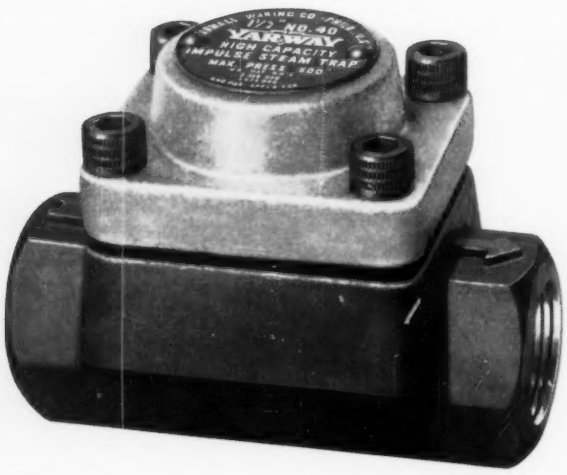
from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*
BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD • STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

THIS STEAM TRAP WILL DISCHARGE 25,500 LBS. OF CONDENSATE PER HOUR

This is a typical installation of a Yarway Series 40 Impulse Steam Trap—a trap designed specifically to gobble up extra heavy condensate loads.

The trap is a No. 48, 2½" size, and is installed on a suction heater connected with an 86,000 barrel tank containing fuel oil at a storage terminal. The operating pressure is 13 psi. At this pressure the trap has a capacity of 25,500 lbs. continuous discharge of condensate per hour.

At operating pressure of 100 psi, the trap's capacity is 62,000 lbs. per hour.



Yarway ½" No. 40 Impulse Steam Trap (shown actual size). Also available in ¾", 1½", 2" and 2½" sizes.

CAPACITY—PLUS

Capacity isn't the whole story on Yarway Series 40 Steam Traps. Like all Yarway Impulse Traps, they offer advantages like quick heat-up, even temperatures, small size, good for all pressures, non-freezing.

Series 40 traps also feature high temperature discharge characteristics, excellent low pressure operation, no airbinding, operation against back pressures up to 40%, and stainless steel construction.

You can get Yarway's latest steam trap Bulletin T-1743, or arrange for a free 60-day trial of a Yarway Impulse Trap, by writing to Yarnall-Waring Company or contacting your local Industrial Distributor.

YARWAY OFFERS IMPULSE STEAM TRAPS FOR THESE SPECIFIC OPERATING CONDITIONS

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Volume 40, No. 2 February 1961

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Petroleum
REFINER
FOR THE HYDROCARBON PROCESSING INDUSTRY
A Gulf Publishing Company Publication

A Quick Look
at this issue

These handy digests permit checking ☑ the articles you want to read first.

PROJECT MANAGEMENT SPECIAL REPORT

☐ **A Checklist for Project Engineers . . .** Checklists can resolve many questions about a project in the shortest time. One of the most important lists in Phase 1 (the pre-contract stage) is the construction questionnaire. To see which questions should be answered about the construction site, both domestic and foreign, turn to **Page 94.**

☐ **What Project Status Reports Mean . . .** The report does more than reveal the satisfactory or unsatisfactory status of the project. Its conclusions and recommendations alert management to situations that may affect completion of the project so they can take corrective action. It also is a direct measure of the project staff's competence. To see how project status reports can help you evaluate your next job, turn to **Page 101.**

☐ **Operating Company's Checklist . . .** A project engineer that follows this guide can be sure that all details have been considered before an expensive building project is launched. Developed from an operating company's viewpoint, this checklist is especially adapted to definitive estimates. For some very useful info, turn to **Page 105.**

☐ **Find Optimum Vacuum Tower Pressure . . .** By using this equation, which includes steam cost, cooling water cost and tower diameter, you can quickly and easily find optimum vacuum tower pressure. You can check your vacuum units now by turning to **Page 112.**

☐ **Now Use Gas Chromatography for Glycol Analysis . . .** The four glycols of ethylene can be defined in solution singly or in mixture with good precision by using the method proposed here. Sugges-

Please Turn Page ➡

Texaco's Ljungstrom Air Preheater is being installed to boost the output of an existing still. This Ljungstrom has 5800 sq ft of heat exchange surface, will preheat incoming air from 50°F to 754°F. The still is the first step in processing crude oil for production of fuels and petrochemicals.

TEXACO INSTALLS LJUNGSTROM® AT LOCKPORT REFINERY

Ljungstrom Air Preheater cuts fuel consumption, boosts still capacity at Texaco's Lockport, Ill., refinery

Ljungstrom cuts fuel consumption. Since placed onstream last year, Texaco's Ljungstrom heat exchanger has been recovering over 700°F from the exhaust of the crude still, and putting this waste heat back into the combustion air.

Ljungstrom boosts still capacity. Preheated combustion air mixes more readily with the fuel, makes it burn more completely, with less slag and fewer deposits. This means less downtime, too.

For more information that will help you solve your heat recovery problem, call or write The Air Preheater Corporation.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

A Quick Look at This Issue . . .

tions are given for making your own chromatographic apparatus. Don't miss this interesting article beginning on **Page 117.**

☐ **Stress-Relieve Welds By Combustion . . .** A new combustible stress-relieving material works like a match-fired, self-vulcanizing tire patch. Simply place the moulded material around the weld, plus insulation, and light with a torch. Because of labor savings, it's cheaper than resistance-heating stress relieving. Kits are big, requiring storage space, and costs go out the ceiling if shipped air freight. To see if you should consider it for your plant, turn to **Page 121.**

☐ **Enthalpy Petroleum Fractions . . .** Whenever you use your enthalpy charts for petroleum fractions don't you later make corrections for high pressures? Here are a set of charts which include the pressure corrections—and they are good clear up to the critical region. This one will save you much time. See **Page 123.**

☐ **Automation Today . . . Part 25 . . .** Adaptive control is one of the most refined methods of control. With this system, a controller can adjust itself to compensate for varying conditions within a process. For some examples of adaptive control be sure to see **Page 133.**

☐ **Trends to Watch in Phthalic Anhydride . . .** Petronaphthalene, xylenes, new processes and catalysts, and changing demand are trends to be watched in phthalic anhydride. All of these are discussed as they affect the growth of dibasic acids. For complete details on this fascinating subject, be sure to see **Page 139.**

☐ **Thermo Data for Petrochemicals . . . Part 26 . . .** You can estimate the Gibbs free energy of formation from group contributions. If you've had to calculate whether or not a reaction will go, then you know the importance of having data on the free energy of compounds. If these are not available in your handbook you need not feel lost. Here is an easy way to predict these important thermo data from group contributions. See **Page 145.**

☐ **New Chart for Packed Tower Flooding . . .** Rearrangement of the basic Sherwood correlation has led to an interesting new chart for packed tower flooding. It is simpler to use and gives more intelligent extrapolation at higher gas and liquid rates. To check some of your packed tower designs, turn to **Page 130.**

☐ **How to Destroy the 'Ugly American' . . .** People in other nations have been seeing a distorted, one-sided and unlikable picture of foreign-based American businessmen. Now a revolutionary new school is helping overseas personnel learn how to show the other side of the coin. Read this interesting article on international public relations, beginning on **Page 151.**

☐ **Rapid Reading . . . Part 1 . . .** If you want to improve your personal efficiency—if you want to read faster and understand more—then you'll be interested in the techniques presented in this exciting new three-part series. Turn now to **Page 155.**

Job Improvement Ideas . . .

Now in its 40th year, PETROLEUM REFINER has always fulfilled its primary purpose. That purpose is to be of service to the Hydrocarbon Processing Industry and the men who work in it.

In an average year, PETROLEUM REFINER will publish more than 1,000 pages of technical, engineering-operating material . . . authored by more than 250 key industry men.

That is why PETROLEUM REFINER is considered the number one source of job-improvement ideas by its over 25,000 paid subscribers.

PETROLEUM REFINER's carefully planned editorial program revolves around staff contacts with pace-setting men throughout the industry. Articles are written, cleared through, checked and reviewed by HPI experts. In an average year, out of a total of 840 manuscripts submitted for consideration, only 240 will be accepted. This is evidence of the strictness of PETROLEUM REFINER's evaluation program.

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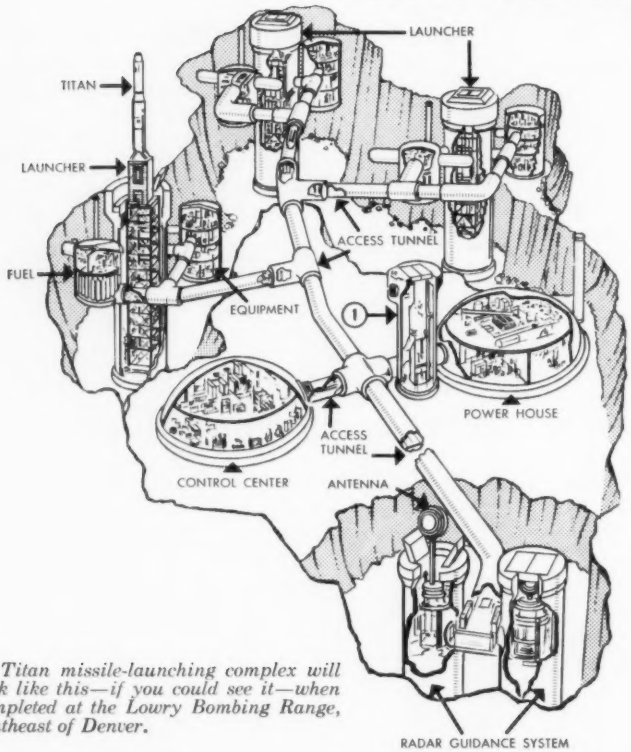
PUMPAGE

Goulds news about pumps for process industries



A Titan missile-launching complex will look like this—if you could see it—when completed at the Lowry Bombing Range, southeast of Denver.

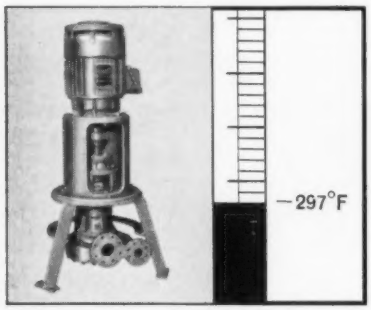
Goulds ductile iron pumps help build TITAN MISSILE MUSCLE

Deep under the Colorado earth, two gigantic Titan missile bases are taking shape. Powerhouse and control center are vast domed structures. Three two-story structures will store fuel. Four-story cylinders will house monitoring and other operating equipment.

Immense and complex, the bases require a wide variety of pumping services. Goulds, the major pump supplier, is building hundreds of units —from vertical sump pumps to high-temperature, high-pressure units.

Many of the pumps *must* be able to stand severe shock so we are making these, or their critical parts, of ductile iron. Castings range from ½ lb. to over 1800 lbs., making up probably the largest order for ductile iron pumps ever placed.

If you'd like to know why ductile iron has unusual resistance to stress, impact, and high pressures, send for Bulletin 765.7.

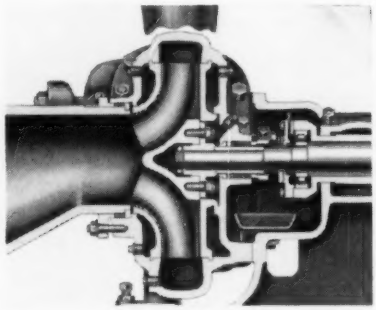


How to pump cryogens

One company pumps liquid oxygen at −297°F with this process pump.

Model 3181's basic design especially fits it for low-temperature pumping. Casing arrangement of suction limits pressure on column, bearings and seal to vessel pressure only. Special magnetic mechanical seal seals shaft.

Cryogens raise special problems in selecting pump design, materials, and seal. Our engineers, experienced in these applications, can help you. Write us.

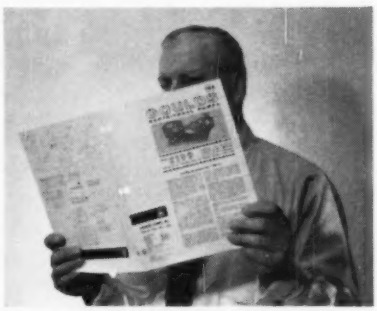


Cotton pickin' pump

Nine Model 3135s pump cotton linter stock *in a smooth flow* for Southern Chemical Cotton Co.

The fine cotton fibers can't clog the open end suction impeller. Ejector vanes on back wall of impeller follow curvature of main vanes, prevent entrance and jamming of stock between wall and stationary sideplate. There is no impeller nut or other obstruction at the impeller eye to catch fibers.

For specifications and performance data, send for Bulletin 723.1.



Now... small-capacity pump for chemicals and slurries

Handles up to 115 gpm of corrosive chemicals, thick or abrasive slurries at heads to 150 ft.

Of single-stage side-suction open-impeller design, Model 3199 has hydraulically balanced impellers with ejector vanes on back wall to keep out solid material and reduce stuffing-box pressure. Bearings are isolated in cooling chamber.

For specs, ratings and other data, write for Bulletin 720.5. Goulds Pumps, Inc., Dept. PR-21, Seneca Falls, New York.

GOULDS PUMPS

For more data on advertised products, use Readers' Service Cards, last page.

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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

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Better Late Than - - -

BUSINESS WRITING tops the list of skills businessmen use most, a survey of business and industry managers showed, according to a Michigan State University business administration professor in November's "Nation Business." Communications and human relations skills were by far the most frequently used of the specific knowledge and skills offered by each of 62 college courses, the survey revealed. And about 80 percent of the managers put skill in letter writing at the top of their list with personnel management second.

This bit of information would have been a natural presented along with PR's December's Special Report on Reporting. But if this belated revelation sparks some reader, who passed it up in the holiday rush, to go back and check the several fine December articles, then it proves again that "it's better late than never."

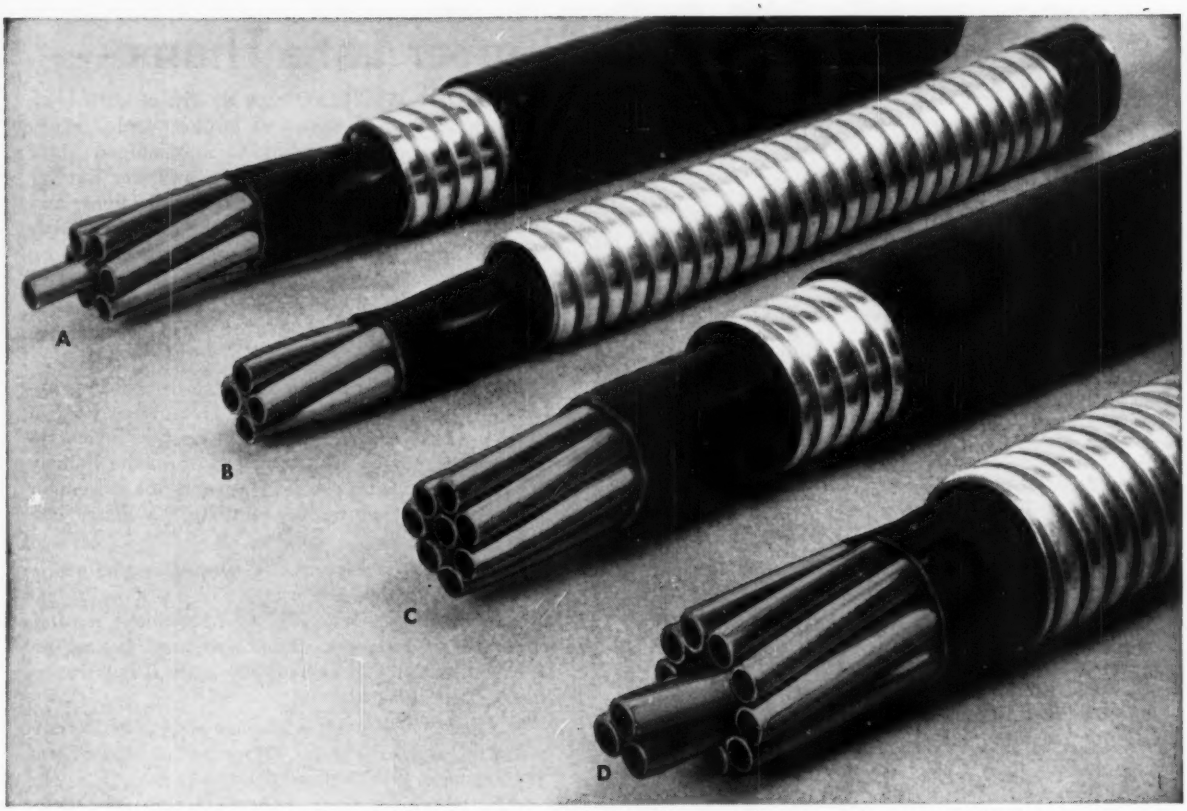
Incidentally, of the seven "most-used" topics nearly all are included in the menu which PR calls "As Management Sees It." The seven: business writing, personnel management, public speaking, human relations, principles of accounting, work simplification and organization.

Incidentally (No. 2), a 20-page reprint of December's "Effective Technical Reporting" is available at 50 cents from GPC's Reprint Department.

Boxscore Aid

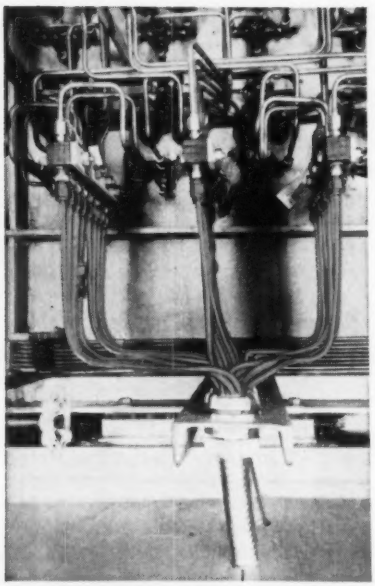
AGAIN in the January issue PETROLEUM REFINER presented Construction Boxscore, and again we would like to point out how the industry itself, and particularly our engineer-constructor friends, can help in making this presentation of even greater value and service. Knowing from long experience, the detail required in its compilation, we would be the last to claim completeness or perfection for these listings. All we can say is that a great deal of effort on a continuing basis is required for the report which is presented quarterly. And we need and will gladly accept all the help we can get. So if you would help, please answer promptly queries that may reach you. Several hundred letters went out late in January calling Boxscore to the attention of operating companies and engineer-constructors and asking them to check their listings and advise PR of revisions or additions needed in perfecting this industry-wide service. All of us will benefit from such cooperation.

The March issue of PETROLEUM REFINER contains a special report devoted to a newcomer in the petrochemical field—polypropylene. This newest polyolefin is grubbing its own place alongside the well established old-timers such as polyethylene, vinyls, phenolics and polystyrene all of which today are enjoying steady growth. Authoritative articles dealing with propylene purification, polypropylene manufacture, and the uses and future growth prospects of polypropylene will give you a thorough picture of this dynamic field.



BAILEY ARMORTUBE is available with *A*, thermoplastic sheath over steel armor; *B*, thermoplastic sheath under steel armor; *C*, thermoplastic sheath over and under steel armor; or *D*, with just steel armor.

For its "Armortube" control system cables, Bailey specifies Anaconda precision copper tube in long coils



A TYPICAL INSTALLATION of Bailey Armortube in a large utility, indicating the large number of separate lines carried by two easily installed cables.

Armortube® flexible, armored, multiple-tube cable made by Bailey Meter Company, Cleveland, Ohio, has saved up to 40% of single-tube installation and maintenance costs in pneumatic, metering and control systems.

Armortube cable is available in lengths up to 1000 feet and in bundles of up to 19 individual ¼" O.D. copper tubes. Steel interlocking armor protects the tubes from mechanical damage and simplifies installation. In addition, various combinations of thermoplastic sheathing are available to provide further protection from moisture and corrosive atmospheres during and after installation.

CLEAN AND DRY. The copper tubes must meet rigid quality specifications, and Bailey has found that Anaconda copper tube consistently meets its requirements. Anaconda takes special care to see that inside surfaces are clean, smooth, and bright—free from dust, dirt, or metal chips which might interfere with the operation of delicate air and hydraulic circuits. Tube ends are sealed to keep out moisture and foreign matter during storage.

FLEXIBLE AND ACCURATE. Anaconda copper tubes are uniformly soft, highly flexible—for easy bending during installation. And they are accurate in size and shape.

LONG LENGTHS. For applications such as instrumentation, Anaconda can produce copper tubing in coils up to 2200 feet for ¼" O.D.—up to 1400 feet for ⅜" O.D.—up to 1000 feet for ½" O.D.

QUALITY TUBE AND CREATIVE TECHNICAL SERVICES. Whatever your requirements for precision copper tubing—instrumentation or capillary tubing, or restrictor tubes—Anaconda specialists can help you find the most economical way to do the job. For such technical assistance, see your Anaconda representative, or write: Anaconda American Brass Company, Waterbury 20, Conn. 6069L

ANACONDA®

INSTRUMENTATION TUBING

Anaconda American Brass Company

For more data on advertised products, use Readers' Service Cards, last page.

Quick Look at Industry...

Eyeing Supply, Demand and Imports . . .

Domestic crude consumption in February estimated at 7.25 million bpd, compared with 7.29 million bpd for January. The breakdown: gasoline demand, 3.83 million bpd; yield of 45.2%; runs of 8.2 million bpd . . . Demand for all petroleum products in U.S., during period February-April inclusive, should average 10.22 million bpd, says IPAA forecast. This is 1.6% less than comparable period last year when March was 30% colder than usual . . . Oil imports into continental U.S. rose in November to 1.88 million bpd from 1.72 million bpd in like 1959 period.

Quick Look Around the World . . .

Bargaining Policy Committee of OCAW approves acceptance by locals of 5% wage increase offered by industry, as long as adjustment amounts to at least 14¢ per hour . . . U.S. Supreme court supports end-use control of natural gas in important Transcontinental Gas Pipe Line case (see page 15) . . . Explosion and fire at Signal Oil Houston refinery—this time a large gasoline tank. Container exploded, spreading fire over wide area. Only shift in wind prevented Texas City-type disaster, said firemen later. Net result: 9 seriously burned, 1 death so far.

Soviet scientists working on development of polymerized acetone—say polyacetone resin may be near commercial realization. Despite disadvantages of high cost of development and extreme effort to get useable end product, could be big breakthrough to another important new resin . . . 600 members of OCAW at Phillips Chemical's Houston plant go on strike. Main issues in disagreement: effective date of contract, benefit opener clause, changes in line of promotion suggested by company . . . First to apply closed-loop computer control to fluid cat cracker, Gulf announces application to start early this year at big Philadelphia unit. (More on page 194.)

Overhaul for Octane Rating System? . . .

Critical looks being taken at octane rating systems. Although auto engine is authority, researchers seek better lab methods. At recent SAE meeting, Du Pont man described better way to detect knocking pressures by filtering unusual pressure signals. Ethyl man blamed past troubles on outmoded knock-testing methods—suggested higher-speed crankshaft, new cylinder, improved knock indicator. Ohio Standard rep suggested lean-rich fuel measurement to select fuels.

Guilty, Says South Bend Price-Fixing Jury . . .

U.S. District Court jury finds 12 oil companies guilty of Anti-trust charges rising from alleged conspiracy to raise gasoline pump prices in South Bend-Misawaka area, May 1957. Defense has filed pending motion for acquittal on grounds convictions aren't sustained by evidence. One defendant, Sun Oil, was acquitted on directed verdict.

Scanning the Process and Product Scene . . .

Cities Service making drum quantities of cyclic-eight carbon petrochemicals from butadiene available to plastics and chemicals manufacturers

for product evaluation, development work. New petrochemical family made possible by development of two new catalysts by Cities Service Research and Development. (More on page 190).

Slumbering "Fuel Policy" Issue Revives . . .

Kennedy Administration appears to favor fuels policy from all sides, while support for same continues to grow in Senate. Look for this issue to flare hot in next few months. API has endorsed "impartial fuels study" and offered industry's cooperation and participation, but warned national fuels policy should be subject of grave concern.

Shortage of Ammonia in Some Areas? . . .

Ammonia, produced to tune of 4.8 million tons in 1960, looks bright for '61. Some areas may even face shortage—but others will have surplus. Over-all, this petrochemical holds best immediate prospect for continuing growth over next several years.

Bright Days for Plastics . . .

The plastics "big three"—polyethylene, polystyrene and vinyls will continue to grow in '61. Already producing more than billion pounds a year, over-all boost in output should range from 5 to 10%. While sales likely to increase in first half, profits may stay same or decline. Price squeeze will be felt again unless long overdue price increases come.

Smog Spotlight Off of L.A. . . .

Despite notoriety of smog, Los Angeles air is cleanest of 4 largest U.S. industrial communities, says latest report by L.A. County Air Pollution Control District. Comparison of dustfall measured in L.A., New York, Chicago and Philadelphia, shows that amount of material settling out of L.A. air is about half that of Chicago, a third that of Philly and New York.

Big Action South of the Border . . .

Look for Mexico to break into petrochemical spotlight in big way late this year. How this will affect imports from U.S. and Canada is much debated question. But with wide variety of projects planned, there is likely to be hefty cut in 7.5 million worth of chemicals Mexico bought from Canada last year, and in $15-million-worth shipped from U.S.

Quick Look at World Wide Construction . . .

Sinclair-Koppers gets one of tallest towers to be lifted in one piece. Part of new Houston styrene plant, tower is more than 227 feet long . . . Humble plans to double Baytown refinery's benzene and toluene production . . . Kerr-McGee Industries plans first privately financed helium extraction plant in U.S., to be built in Arizona . . . Murphy Corp. slates new units for Superior, Wis., refinery, including, 5,000-bpd cat cracker, 1,200-bpd alkylation unit—others.

Meanwhile, on petrochemicals scene, Humble at Baytown plans to double benzene and toluene capacity for total of 110 million gallons a year. . . Suntide Refining starts construction of 30-million-pound-a-year ethyl benzene separation unit at Corpus Christi, Texas . . . Reichold Chemicals to build 50-million-pound-a-year vinyl acetate monomer plant in Houston. More about construction on page 170.

That's the amount of catalyst that Buell cyclones are collecting in fluid cat crackers every day . . . enough to build a pyramid the size of the Great Pyramid of Cheops. Operating experience has convinced refineries to rely on Buell Cyclone Systems for minimum catalyst loss. Buell systems for fluid bed processing include: fluid catalytic cracking units, hydroforming, coking, coal carbonization, iron ore reduction. To meet the most stringent air pollution codes refineries also prefer a combination system with Buell Electric Precipitators. Buell Engineering Company, Inc., Department 21-B, 123 William Street, New York 38, New York; Northern Blower Division, 6401 Barberton Avenue, Cleveland, Ohio. Cyclones • Electric Precipitators • Bag Collectors • Combination Systems • Classifiers • Fans

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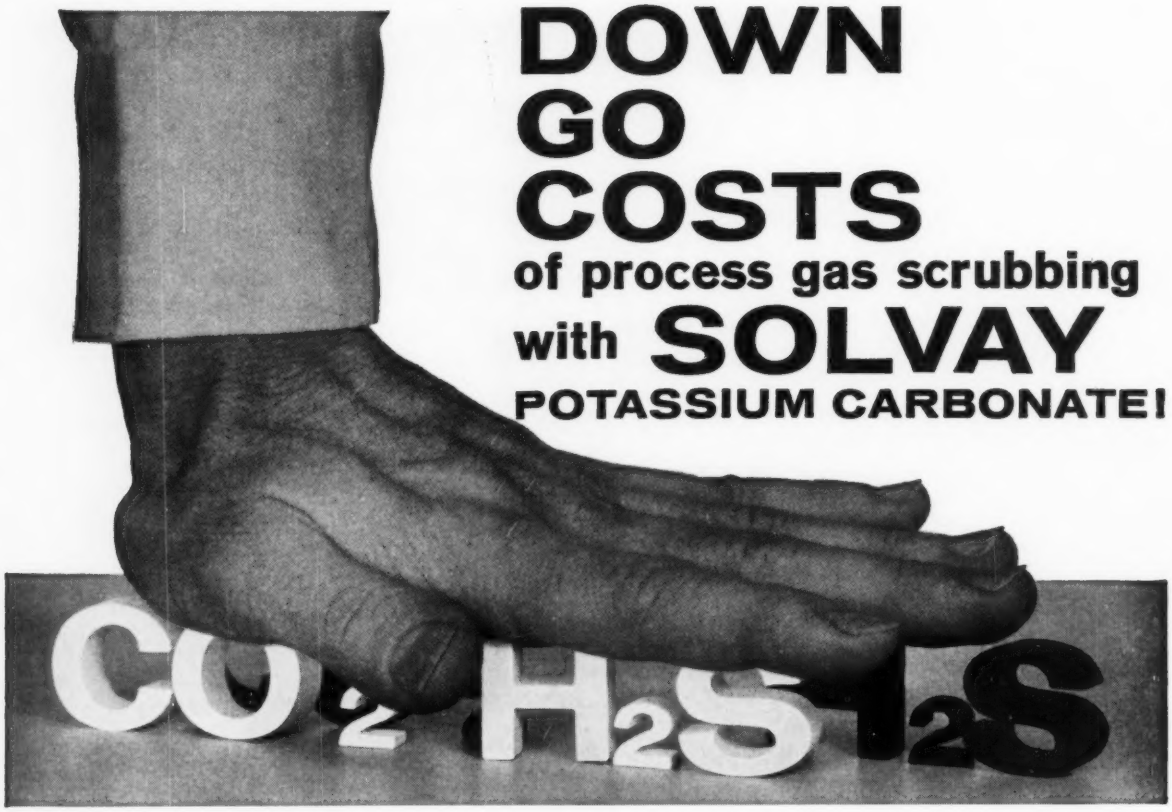

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- ☐ "Improved Process for CO_2 Absorption"—Chemical Engineering Progress.
- ☐ "Hot Potash Process for Gas Purification"—Oil and Gas Journal.
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Are Specifications Just Words?

J. E. Lattan and F. S. G. Williams, Taylor Forge & Pipe Works, Chicago

THE MAJORITY of specifications are written for *very broad coverage of end use.* This is quite proper because the objective is to achieve a standard that, by its interchangeability, permits reduced manufacturing costs, warehousing costs, etc.

A good example of this is Specification A312 for stainless steel pipe. This was written to serve the food industry and the low-pressure phases of the chemical and petroleum industry. That's good, but is this the right specification to use on high-pressure nuclear service, or high temperature hydrocarbon service? In terms of the pipe produced by a particular mill, it might well be, but, does the specification contain the testing and inspection requirements that the high quality mill applies to its products?

The answer is probably "no." Close coordination of the purchasing and engineering groups can handle this situation but it requires understanding knowledge on the part of both groups of the "words" of the specification and the mill practices of the various potential suppliers.

Alertness Needed. Specifications and standards are frequently very broad in their coverage of product size. A good example of this is ASTM Specification A105, which has been used for forgings that vary from something like 3 pounds to 10 or 15,000 pounds in weight. A parallel is ASA Standard B16.5, which covers products from ½ inch to 24 inches.

Again, for good reasons, we have specifications that in one document embrace many manufacturing methods. A good example of this is ASTM A53, under which the purchaser may get butt-weld, lap-weld, electric resistance weld or seamless pipe. There are several service applications where any of the four methods of manufacture would be perfectly adequate. There are other applications where the designer would be imprudent indeed, if he did not specify the manufacturing method. The point is that the user, purchaser and the Code Committee should all be alert to this and recognize their respective responsibilities as to selections possible under the specification.

There are certain standards which are very limiting with respect to intended end use, method of manufacture, etc. Good examples of this are ASTM Specifications A376 and A430. These, however, are the exceptions rather than the rule.

Many standards quite properly contain open end clauses. There is nothing wrong with this, but the user and the Code Committee must be aware of this and discriminating in their attention to this detail when assigning a specification number to an engineering design. Some of these clauses have no effect on quality. Others distinctly affect quality and it is to these that we point most specifically.

The range of chemical requirements in material specifications can be important. There are aspects of serviceability that can be quite significant, particularly to the engineer who is new to a field of service. These factors usually take time and, sometimes, time at temperature to cause trouble. A good example of this is the high temperature use of stainless alloys. With the wide range of chemistry permitted under these specifications and, particularly under the casting specifications, a considerable amount of free ferrite can be present. This might be perfectly acceptable for room temperature service and, as a matter of fact, some endeavor to make a case for free ferrite's being a virtue because of room temperature physical properties. If this same material were being used at temperatures over 800° F approximately, this free ferrite, according to many competent metallurgists, would be very deleterious to service reliability.

Old Principle Takes Over. The message here is very clear. The designer and the Code Committee must be very careful that the inexperienced user of this specification is not misled in his selection of materials.

Still on the subject of chemistry, very few users of specifications realize that the American specifications are written around American steel-making practices.

The ores and the melting practices we use, keep such ingredients as nitrogen and arsenic to such low levels that, by common consent, American specifications do not call for reports on these constituents. Combine this with the fact that almost all foreign steel and steel products coming on the American market are handled through brokers who have no long-term responsibility in the picture, and you will see how quickly the old principle of "caveat emptor" takes over. This is particularly important when it is realized that a large part of the European melting is done by the Basic Bessemer process (Thomas Steel), and that many of the ores leave considerable arsenic residuals in the steel.

The embrittling effect of excessive nitrogen in carbon steel is well known, but many are not aware of the fact that arsenic has a similar effect; and when there is a combination of nitrogen, phosphorus and arsenic, the properties of the material may be very

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New facilities at our plants in South Lyon, Michigan, and Rosenberg, Texas, are now producing the longest seamless steel tubing in the industry—in lengths of 85 feet or more, for use in feedwater heaters, in nuclear power plants, wherever high-pressure application is required.

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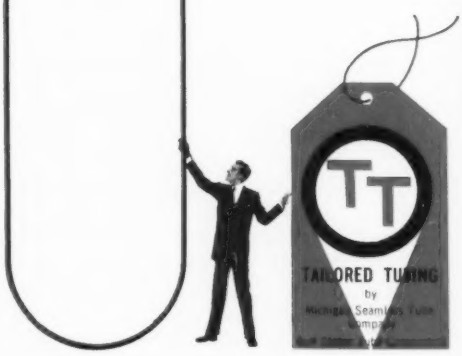

Steel

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different indeed from those expected, or even required.

It should be remembered that American specifications are silent on this point for very sound reasons, and, therefore, great caution should be exercised in applying American specifications to materials melted in other areas.

In the field of inspection, we repeat that the standards and specifications are no more meaningful than the inspection which the purchaser demands. The responsible manufacturer welcomes opportunities to demonstrate the quality control that he exercises in maintaining the desired quality.

In view of the volume of merchandise being produced in this country, the certification of products has become a necessity. But the value of this certification is meaningless, unless supported by the owner's inspection to establish its validity.

Markings. Code Committees and owners alike have come to place great reliance upon the requirements of standards that products be marked with the manufacturer's name and other data and that such marking may not be removed. There are on the market today, however, a great many items of pressure equipment on which the marking is not that of the original manufacturer. "Caveat emptor" again—"let the buyer beware."

(From a paper originally presented to the ASME Petroleum Mechanical Engineering Conference in New Orleans, September 18-21, 1960 and just released for publication by the authors.)

A Peg for The Coal Industry

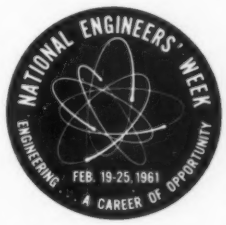
THE U.S. SUPREME COURT has handed down another controversial decision of extremely important significance and far reaching implications. This time, it has made an issue of the end use of natural gas. The decision: A ruling on an application by Consolidated Edison Co., New York, on gas to be used for fuel in its Waterside plant, instead of coal. The firm contracted with Transcontinental Pipe Line Corp. to transport the gas for them.

A clause in the contract protected customers during cold weather. The FPC denied the application, and the parties appealed to the U.S. Court of Appeals, which sustained them. The Supreme Court reversed this decision, holding that the gas would be put to an "inferior use" as a boiler fuel.

This terminology ("inferior use") used by the court is tremendously significant. Because U.S. Supreme Court decisions are final precedent cited in all inferior or trial courts, the Consolidated Edison case goes on record as a peg case on which the National Fuel Policy advocates can hang their hats. The nebulous terminology "inferior use" is a surefire victory for the coal industry. Watch for future editorial discussions in these columns setting out all the issues in this important court decision.

"Engineering— A Career of Opportunity"

FEBRUARY 19 TO 25 is National Engineer's Week, celebrated annually during the week of George Washington's birthday in recognition of the fact that our first president was also the nation's first great engineer.



This year the theme for National Engineer's Week is "Engineering—A Career of Opportunity." In cooperation with industry, schools, merchants, and publishers, national chapters of the Society of Professional Engineers are trying to interest young Americans in engineering as a career in an attempt to fill the tremendous need for engineers in the unlimited fields of the future.

To get some idea of the advance of engineering as a profession, we need only observe that in 1900 there were 225 industrial workers for each engineer. By 1955 there were only 55 industrial workers for each engineer. This trend has been marked by increased purchasing power of individual workers—largely because of increased utilization of process and product engineering.

Thus, as engineers continue to grow in number, stature and importance in the community, their responsibility to their profession and to the public increases. It is with this in mind that the Canons of Ethics for Engineers was prepared by the Engineer's Council for Professional Development. Sections 3 through 7 of the Canons, dealing with relations with the public, are reproduced below with the hope that all engineers in the HPI will conscientiously renew their vows to uphold the highest standards of the engineering profession.

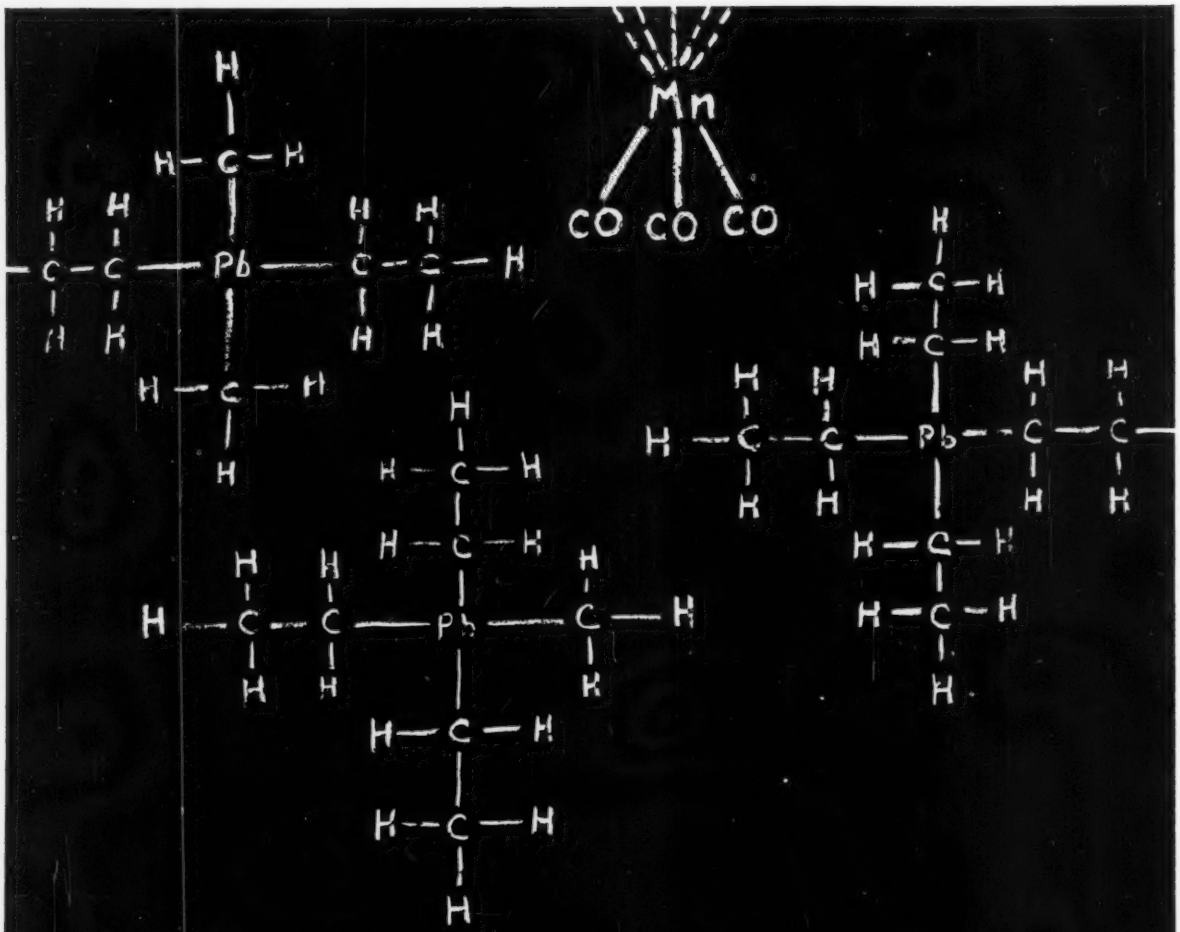
SEC. 3. *The engineer will endeavor to extend public knowledge of engineering, and will discourage the spreading of untrue, unfair and exaggerated statements regarding engineering.*

SEC. 4. *He will have due regard for the safety of life and health of the public and employes affected by work for which he is responsible.*

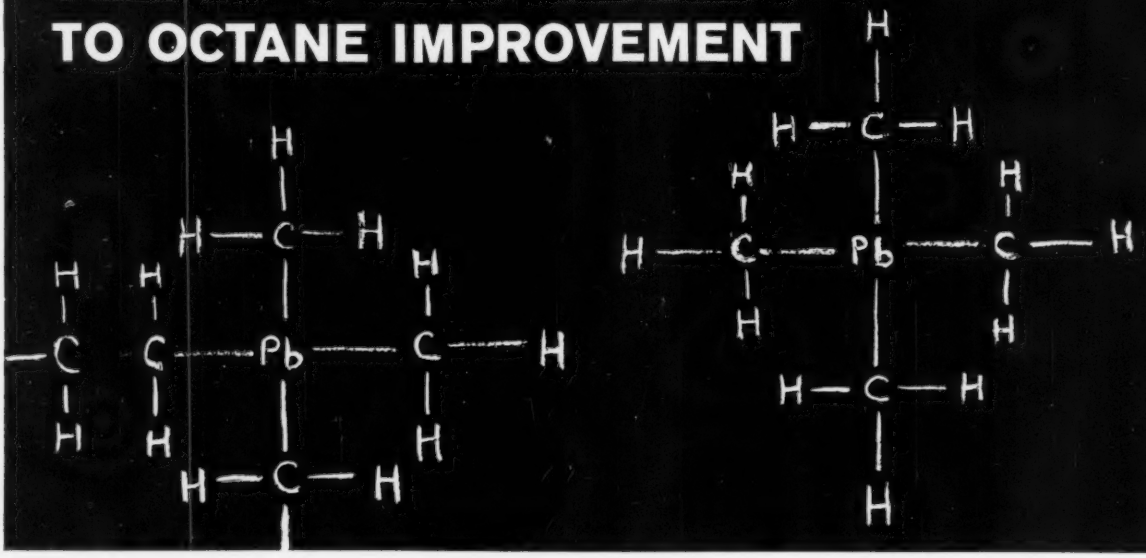
SEC. 5. *He will express an opinion only when it is founded on adequate knowledge and honest conviction while he is a witness before a court, commission or other tribunal.*

SEC. 6. *He will not issue exparte, criticisms or arguments on matters connected with public policy which are inspired or paid for by private interests, unless he indicates on whose behalf he is making the statement.*

SEC. 7. *He will not express publicly an opinion on an engineering subject unless informed as to the facts relating thereto.*



ANTIKNOCKS ADD A NEW FLEXIBILITY TO OCTANE IMPROVEMENT



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RECENT DEVELOPMENTS in antiknock compounds have opened new areas for the refiner to consider. Just as raising the allowable limit of TEL concentration provided more latitude, new antiknocks are now available which permit even greater flexibility.

Bonus from TEL

One of the most important developments in the use of TEL came about during 1959—extending the limit to 4 ml per gallon. As a result, the average premium gasoline refined today can be increased from current levels by one and a half Research octane numbers through TEL alone. Similarly the Motor octane number gain is almost two numbers greater. Furthermore, the Road octane gain from TEL is greater than is indicated by either of the laboratory methods.

In the case of regular gasoline, almost two octane numbers can be gained through increasing TEL from present average concentration to 3 ml. The 4th ml of TEL makes possible additional octane improvement.

Tetramethyllead

Research on tetramethyllead—first of a new group of lead alkyls to be offered commercially—shows that in highly aromatic gasolines or in engines prone to induce fuel segregation in the manifold, TML can be considerably more effective than TEL in its road performance.

Mixed Lead Alkyls

Now three more "Ethyl" antiknock compounds are available: MLA 250, MLA 500 and MLA 750—all produced from mixtures of TML and TEL processed to equilibrium composition. Current tests show that these mixed lead alkyls are selective in their ability to provide superior road performance, dependent upon such factors as fuel composition.

Custom Blends

You may find that a physical mixture of TEL and TML in some special ratio is most effective for your needs. Such "custom blends" are available.

Motor 33 Mix

Another compound, Motor 33 Mix—a manganese-lead antiknock—can supply several additional octane numbers when used in certain fuels.

The Future

With this variety of antiknock compounds, each with its particular value and application, maximum flexibility is offered to the refiner. Not only do the antiknocks offer cost savings and delay capital expenditures, but they can provide benefits that cannot be obtained any other way.

REMINDERS TO REFINERS

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Antiknocks give you a Road octane bonus you can't get any other way.

Gasoline sensitivity can be decreased with antiknocks.

Refining flexibility can be increased with antiknocks.

Antiknocks also can reduce or delay capital investment in octane improvement equipment.

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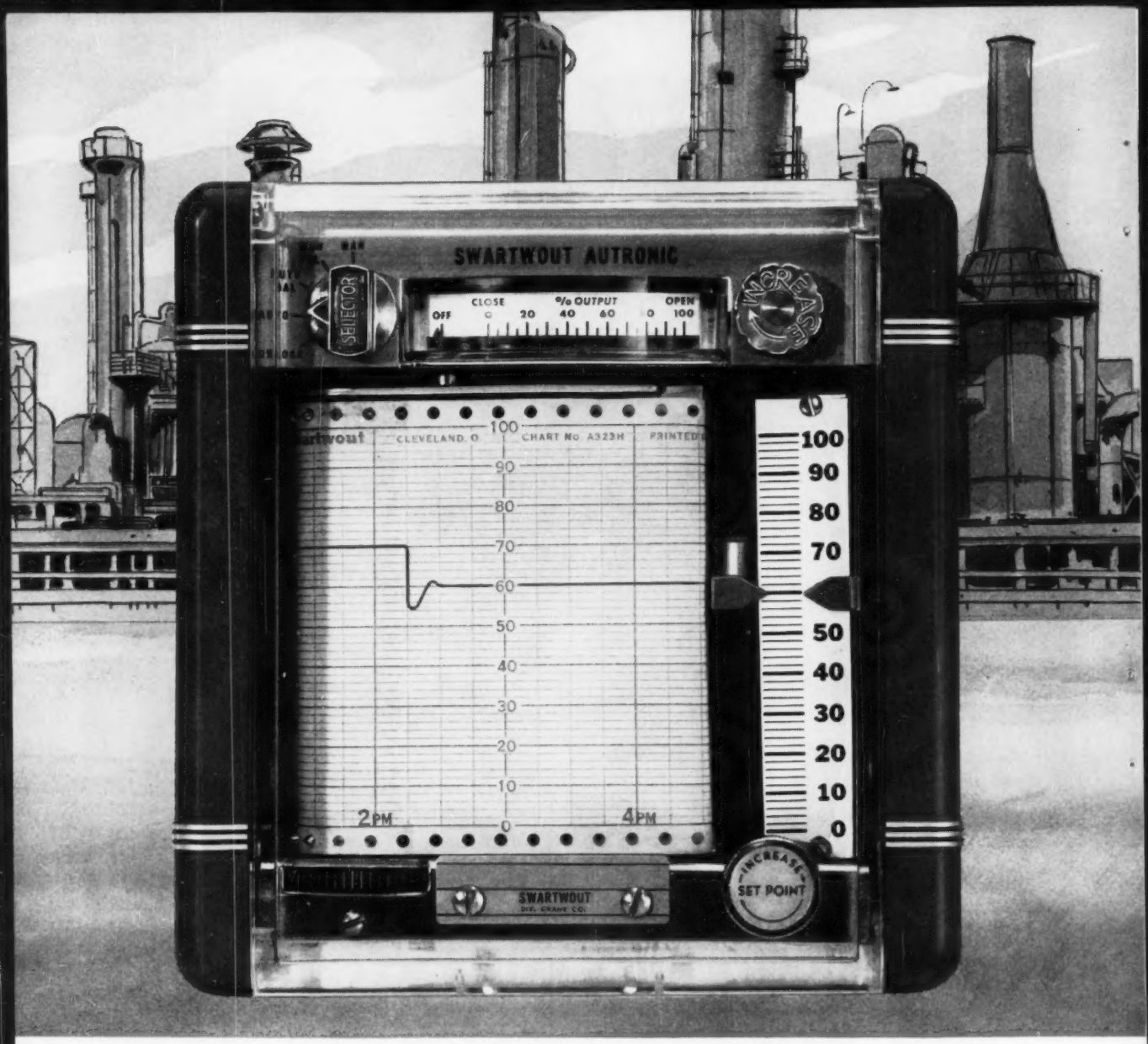

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Another Zebra advantage is this: it's made in half sections exclusively . . . even for the larger pipe sections. The result is speedier application with fewer joints. Zebra is also relatively lightweight . . . easy to cut and fabricate. It can be re-used . . . dismantled and re-applied. No skin abrasion or cuts either. Zebra has a smooth surface.

Write today for more information and a free sample of "K&M" Zebra—the rugged new pipe insulation that's fast to apply. Keasbey & Mattison Company, Ambler, Pa. Dept. I-221.

• for temperatures of 200° F to 1200° F • made of calcium silicate-asbestos fiber bonded felts • meets requirements for density, conductivity, modulus of rupture, and resistance to soaking heat • available in a wide range of sizes and thicknesses.

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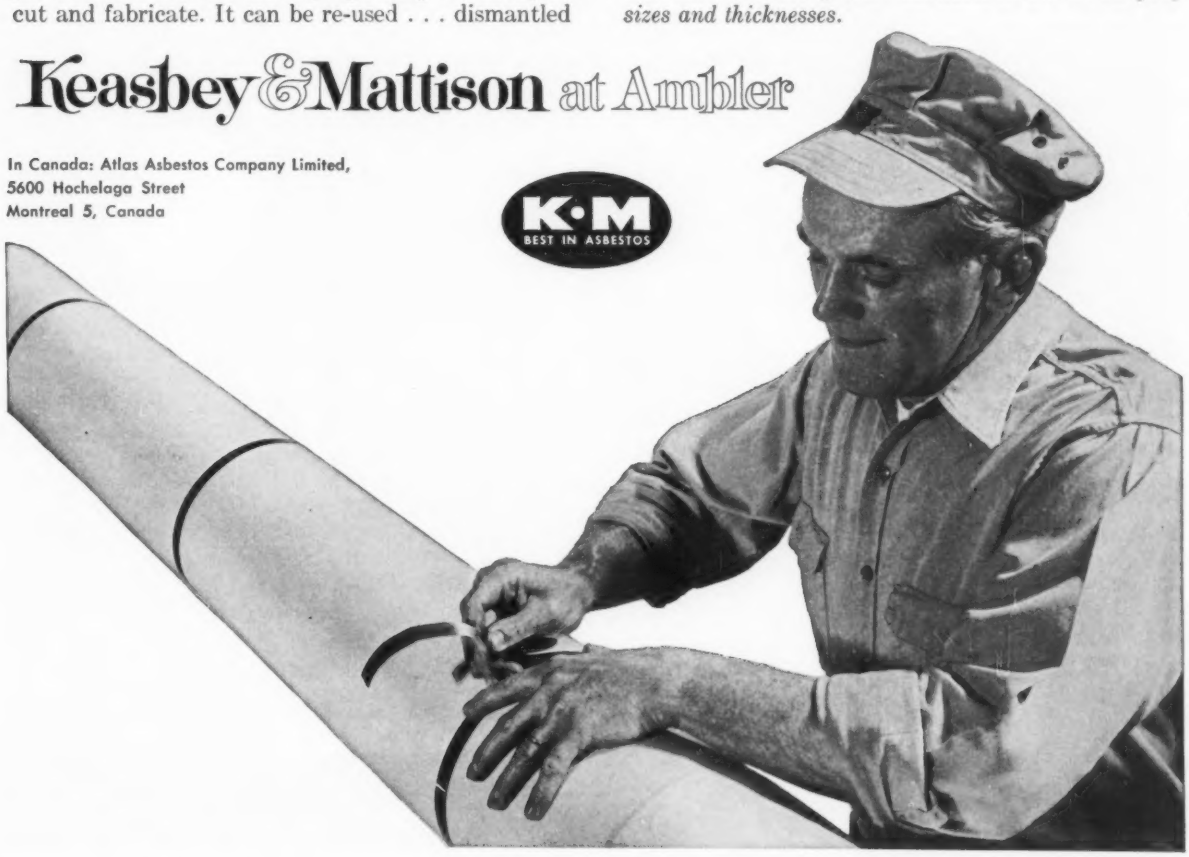

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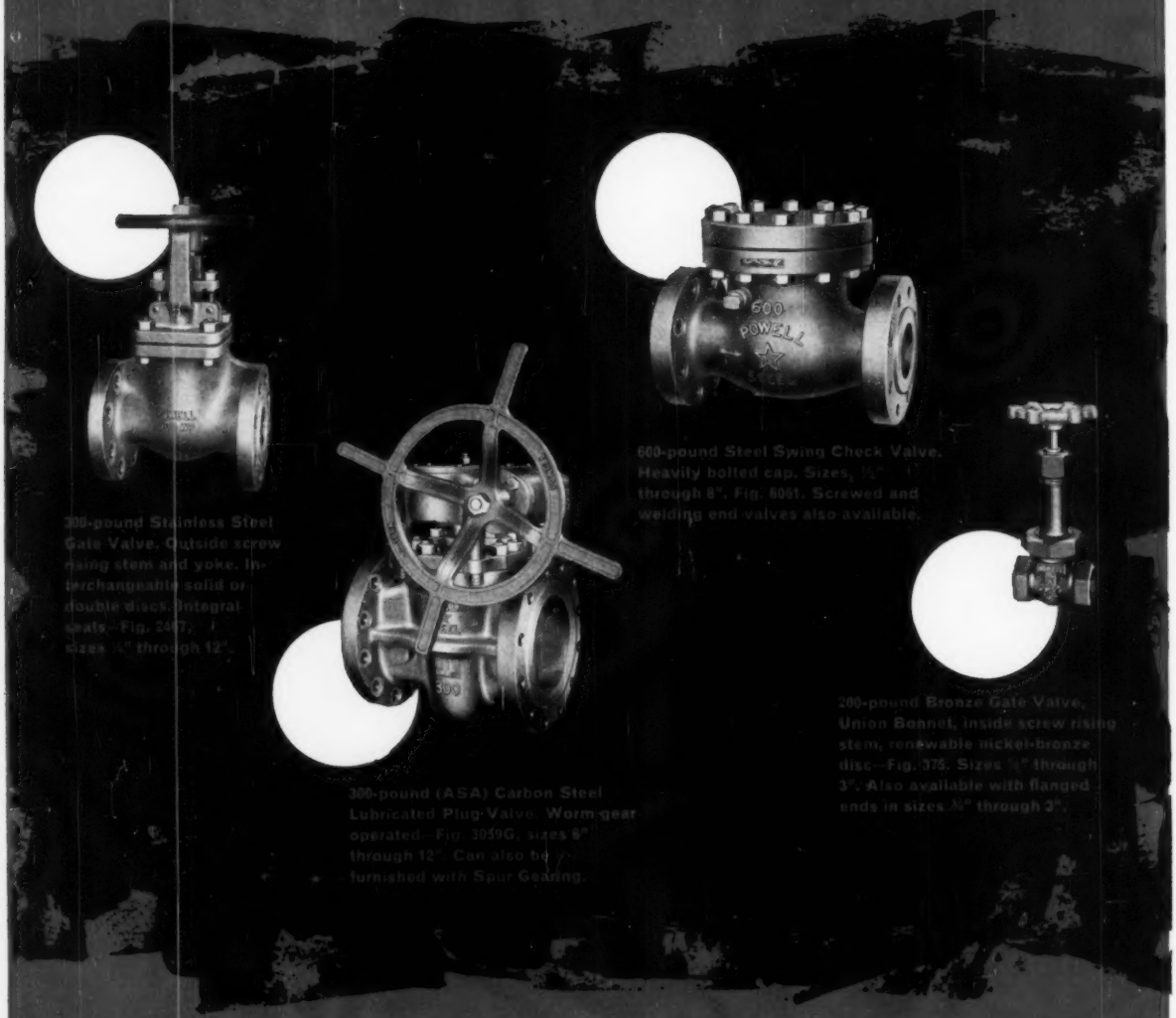

300-pound Stainless Steel Gate Valve. Outside screw rising stem and yoke. Interchangeable solid or double disc. Integral seats. Fig. 2467. Sizes ¼" through 12".

600-pound Steel Swing Check Valve. Heavily bolted cap. Sizes ¼" through 8". Fig. 8061. Screwed and welding end valves also available.

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INDUSTRY IQ QUIZ

Test your industrial IQ with this quiz on the current issue of PETROLEUM REFINER

1. Contractors find the most difficult projects are those dealing with:

(a) experienced owners

(b) inexperienced owners

2. The project status report tells management which one or more of the following?

(a) Acts primarily as a recording document.

(b) Reports on satisfactory and unsatisfactory status of the project.

(c) Is mainly used as a visual indicator of project progress.

(d) Alerts management to corrective actions that should be taken.

(e) Measures the project staff's competence.

3. Definitive estimates are used when the owner wants the earliest possible completion of a project. True or False?

4. In a reduced crude vacuum tower, how would a 5 percent increase in operating pressure affect tower diameter?

(a) Less than 10 percent

(b) More than 10 percent

(c) No affect

5. Does water prevent analysis (by gas chromatography) of solutions containing glycols of ethylene?

6. Combustible stress-relieving kits can save you money in stress-relieving field welds. True or False?

7. Does the enthalpy of a complex petroleum-liquid fraction increase or decrease with an increase in pressure?

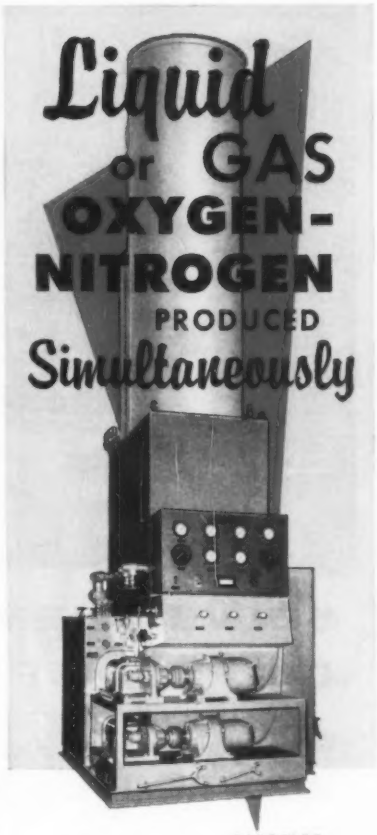
8. An adaptive control system is one which can be coupled to any process, and which will adapt itself to the requirements of that process. True or False?

9. More phthalic anhydride is made by the fluidized-bed process than by any other method. True or False?

10. Although thermodynamic data may be evaluated precisely from group contributions, the calculations involve long, tedious manipulations and a basic understanding of quantum mechanics. True or False?

11. Why is it difficult to visualize the effect of gas and liquid rates independently when using the basic Sherwood plot for packed-tower flooding capacity?

Answers on next page



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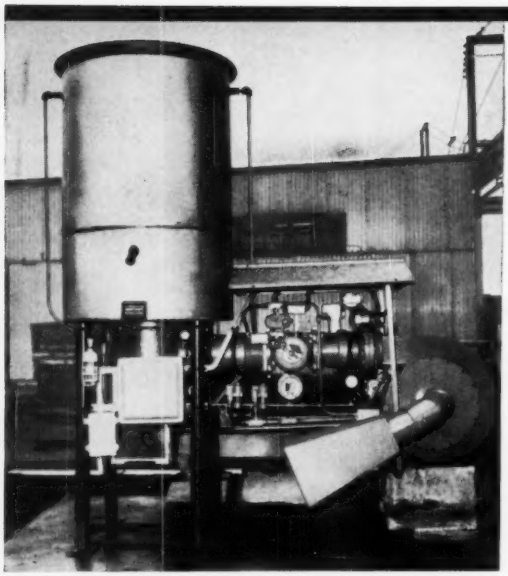

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Long established as one of the most efficient heat sources available to industry, THERMAL high heat release burner equipment provides rapid, efficient, economical incineration of combustible liquid and gaseous wastes. Because of its unique design, wastes can be fed directly into the burner, eliminating the need for bulky, expensive incinerators. THERMAL installations are compact, flexible and require minimum maintenance. Efficient heat recovery can also be arranged. Find out how this system can solve your waste disposal problems. Write today for information.

THERMAL WASTE DISPOSAL SYSTEMS have proved their effectiveness with these waste materials:

GASEOUS	LIQUID
Wax kettle fumes	Acetone-Acetic acid mixture
Phosgene	Ethyl alcohol
Smelter fumes	Phenol still residues
Hydrogen Sulfide	Diethylenetriamine Tar
Plastic plant wastes	Paint & Lacquer residue
Ammonia fumes	Organic insecticide wastes
Phthalic Anhydride	Nitrated & chlorinated aromatics
Acetylene, methane & hydrogen mixture	Ethyl ether
Carbon disulfide vapors	Dimethylformamide & formic acid
	Benzene

✳ Use THERMAL's extensive lab facilities for trial burnings of your waste materials. Our engineering staff is available to do complete turn-key designs to meet your specific needs.

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- Heat Exchangers
- Air Heaters
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- Submerged Combustion
- Combustion & Heat Transfer Equipment

Industry Quiz Answers

(Page 21)

1. The inexperienced owner presents the biggest problem. Owners find the most difficult projects are those agreements made strictly on a price basis without regard to the contractor's background or ability. So says the article "Engineering Contractor Checklist for Project Engineers," **page 94.**

2. A properly executed status report is an indispensible document to management because it gives them information listed in alternatives (b), (d) and (e), according to "What Project Status Reports Mean," **page 101.**

3. True. The owner can release a contractor to proceed with the design and construction along with prepartion of a complete definitive estimate to establish the contract price later. See more in "To Operating Companies: A Checklist for Project Engineers," **page 105.**

4. (a), less than 10 percent—because loading controls the tower diameter according to the expression $\frac{d_2}{d_1} = \left(\frac{P_1}{P_2}\right)^{1/4}$. You'll find other interesting problems solved in "Find Optimum Vacuum Tower Pressure," **page 112.**

5. No. You can learn how one solvent can analyze samples typical of Udex or Glycol-Amine solutions by reading "Now Use Gas Chromatography for Glycol Analysis," **page 117.**

6. True. In many instances this new type of stress-relieving material can save you money. In the article "Stress-Relieve Field Welds by Combustion," **page 121,** an example gives the cost of stress-relieving a 6-inch, schedule 80 pipe-to-pipe weld at $46 using this method. The electric induction method would cost $51.50 for the same job.

7. It will increase, though this is contary to most of our academic training (where the effect of pressure on enthalpy was considered negligible). Be sure to read "Enthalpy of Petroleum Fractions," **page 123.** You'll find some charts that are a "must" if you want to be more accurate at higher pressures.

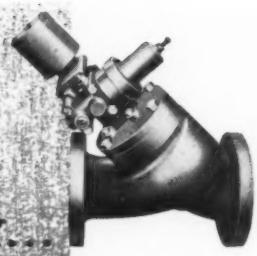
8. False. Adaptive controls usually are designed to accommodate only one type of process. But they do adapt themselves to varying conditions of the process while in operation. For more valuable information, don't miss "Automation Today, Part 25," **page 133.**

9. False. Fixed-bed oxidation processes still lead in total capacity, but fluid-bed processes can't be counted out. Bring yourself up-to-date on PA and other dibasic acids by reading "Trends to Watch in Phthalic Anhydride, **page 139.**

10. Both true and false. Yes, the statistico-mechanics calculations are involved and longhaired—but a rapid, simple method is described in "Thermo Data for Petrochemicals, Part 26," **page 145.**

11. Because the gas rate appears in both the abscissa and ordinate! For a new design chart that separates these two important variables—one that is simpler to use and permits more intelligent extrapolation—see "New Chart for Packed-Tower Flooding," **page 130.**

For more data on advertised products, use Readers' Service Cards, last page.



*

COMPLETE ADAPTABILITY...

BRODIE Series 500 Control Valves

SMOOTH RESPONSIVE CONTROL

with MINIMAL Line Pulsations

The unique design features of the new Brodie Series 500 Control Valves give smooth responsive control of extreme variations in flows and pressures. Large rectangular ports with resulting standard linear characteristics hold turbulence, shock-waves and line pulsations to a minimum. This Brodie design means smooth openings and closings that approximate the shock-free ultimate.

All Brodie Series 500 Control Valves, 2" to 12", up to 600 psi and 150° temperature have standard linear characteristics. For complete details on these valves—write for Bulletin 668 today!

05V

BRODIE

VALVES · METERS

RALPH N. BRODIE COMPANY

San Leandro, California, U.S.A. Cable Address: "BRODICO"

MT. VERNON, N.Y., 550 So. Columbus Ave.
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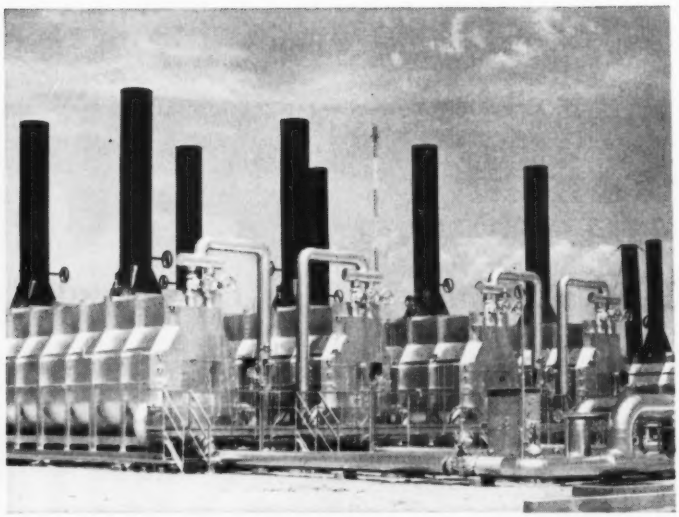
CHICAGO OFFICE: 1227 Circle Ave., Forest Park, Ill.
LOS ANGELES 22, CALIF., 5601 Sheila Street

*Remote Control • Differential Pressure • Rate of Flow • Pressure Relief • Pressure Regulation • Surge Control • Check Valve • Thermal Pressure Relief • Safety Shut-off.

REPRESENTATIVES WITH STOCKS AND SERVICE FACILITIES IN ALL PRINCIPAL CITIES



100,000 to 200,000,000 BTU

PETROCHEM VERTICAL AND HORIZONTAL DIRECT FIRED HEATERS

For the petroleum, chemical and petrochemical industries, Yuba now offers the most complete series of direct-fired heaters available. From 100,000 to 200,000,000 BTU per hour – from -200° to +2,000° F – Petrochem Vertical and Horizontal Heaters can be built in every size and type for every use in any location!

Yuba Heaters are available from the most simple horizontal design to the famous Petrochem vertical with optional reradiation cones for even heat distribution and maximum efficiency.

Working closely with both customer and prime contractor, Yuba can provide single piece, shop-assembled horizontal heaters *to 30,000,000 BTU*. Other heaters up to 50,000,000 BTU can be provided in two sections. For field installations of larger heaters, Yuba can provide well-trained supervisory personnel when desired. Get the complete story on Petrochem direct-fired heaters from Yuba – your largest single, fully-integrated source of supply.

Other Yuba Products For The Petroleum, Chemical and Petrochemical Industries – Adsco Expansion Joints, Transaire Air-Cooled Heat Exchangers, Shell and Tube Heat Exchangers, Southwest Floating Roof Tanks, Cone Roof Tanks, Pressure Vessels, Field Erection, Columns and Towers, Process Condensers, Custom Fabrication.

YUBA

specialists in process heaters – every size, capacity and duty

YUBA TULSA CORPORATION
Tulsa, Oklahoma

YUBA CONSOLIDATED INDUSTRIES, INC.

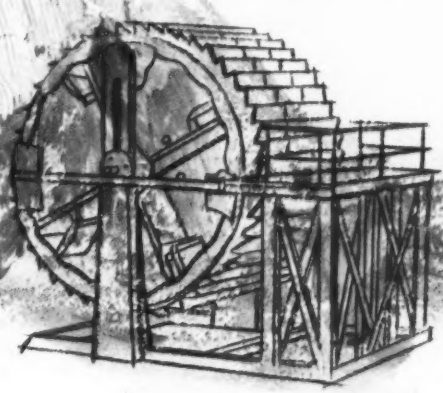
Sales Offices In Chicago • Houston • Los Angeles • New York • Pittsburgh • San Francisco

For more data on advertised products, use Readers' Service Cards, last page.

THE QUALITY OF THINKING

From an almost unlimited scope of thought, Leonardo da Vinci brought forth a stream of inventions which — in modern form — are in use today. However, Leonardo's greatest contribution was simply the triumph of creative thought applied to practical results. His work will stand for all time as proof that the appraisal of quality applies to thinking as well as to tangible objects and to visible or audible processes.

In a related sense, the quality of engineering is measured by results. And it is by results alone that the minds responsible for an engineering project can be evaluated. When you check the record of Brown & Root's engineering through the years, the high quality of thinking is self-evident. Customer satisfaction from greater efficiency at lower costs has built a worldwide reputation for engineering and construction by Brown & Root.



This squirrel-cage blower, invented by Leonardo da Vinci and put to practical use, was a significant step toward modern mechanical air conditioning.

BROWN & ROOT, INC.

Engineers · Constructors

POST OFFICE BOX 3, HOUSTON 1, TEXAS

NEW YORK • WASHINGTON • LONDON • EDMONTON • MONTREAL
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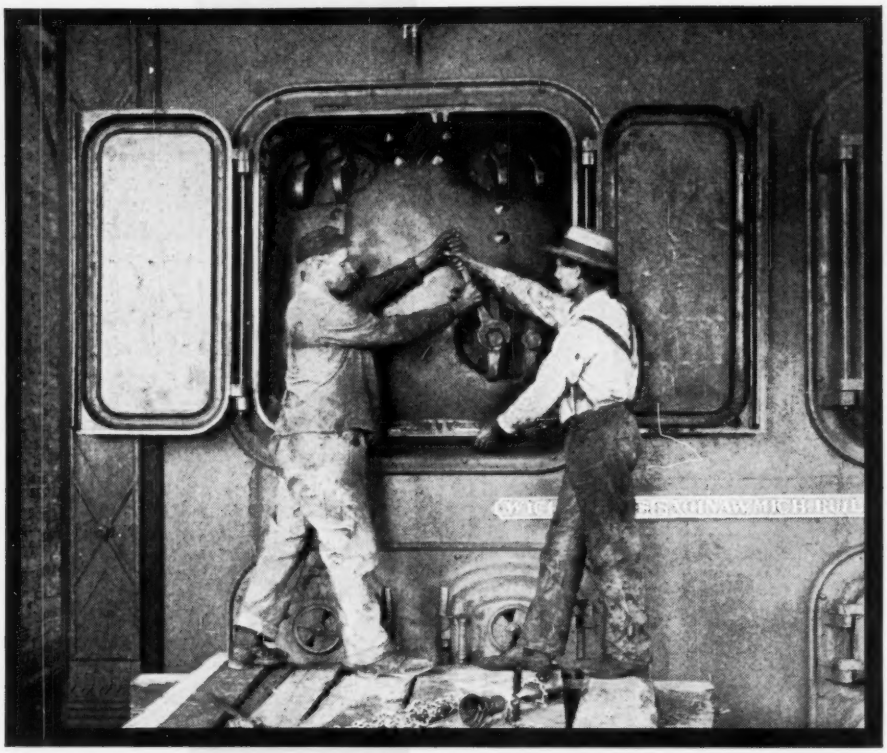
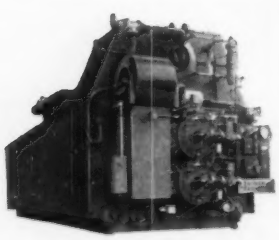


This boiler, built by Wickes Boiler Co. in 1875, operated satisfactorily for the next 31 years.

When buying modern Boiler Equipment it pays to deal with an *EXPERIENCED MANUFACTURER*

There is no substitute for experience. From the first pioneering days in boiler manufacture, years before the boiler pictured above was built, Wickes Boiler Co. has continued to be a world leader in the development of economical, efficient and dependable steam generators. Today, Wickes builds steam generators in sizes to 500,000 lbs. of steam per hour, for high or low steam pressures and temperatures and for all types of fuels and firing methods.

A Wickes steam generator, custom engineered to exact generating requirements, is built to the highest standards of workmanship, backed by over a century of boiler making experience.



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THE WICKES CORPORATION · ESTABLISHED 1854

WICKES

175

WICKES BOILER CO. DIVISION OF THE WICKES CORPORATION, SAGINAW 18, MICHIGAN

For more data on advertised products, use Readers' Service Cards, last page.

ROTARY OR CENTRIFUGAL

...Which one is best for your application?

Rotary or centrifugal? Sometimes the choice is easy. For example, you would use a rotary pump for very viscous liquids (over 2500 s.s.u.). Or where poor suction conditions exist. Or when positive displacement is required. Centrifugal pumps would be used for extremely corrosive or abrasive liquids, low viscosity liquids (under 2500 s.s.u.) water, slurries, or petroleum products.

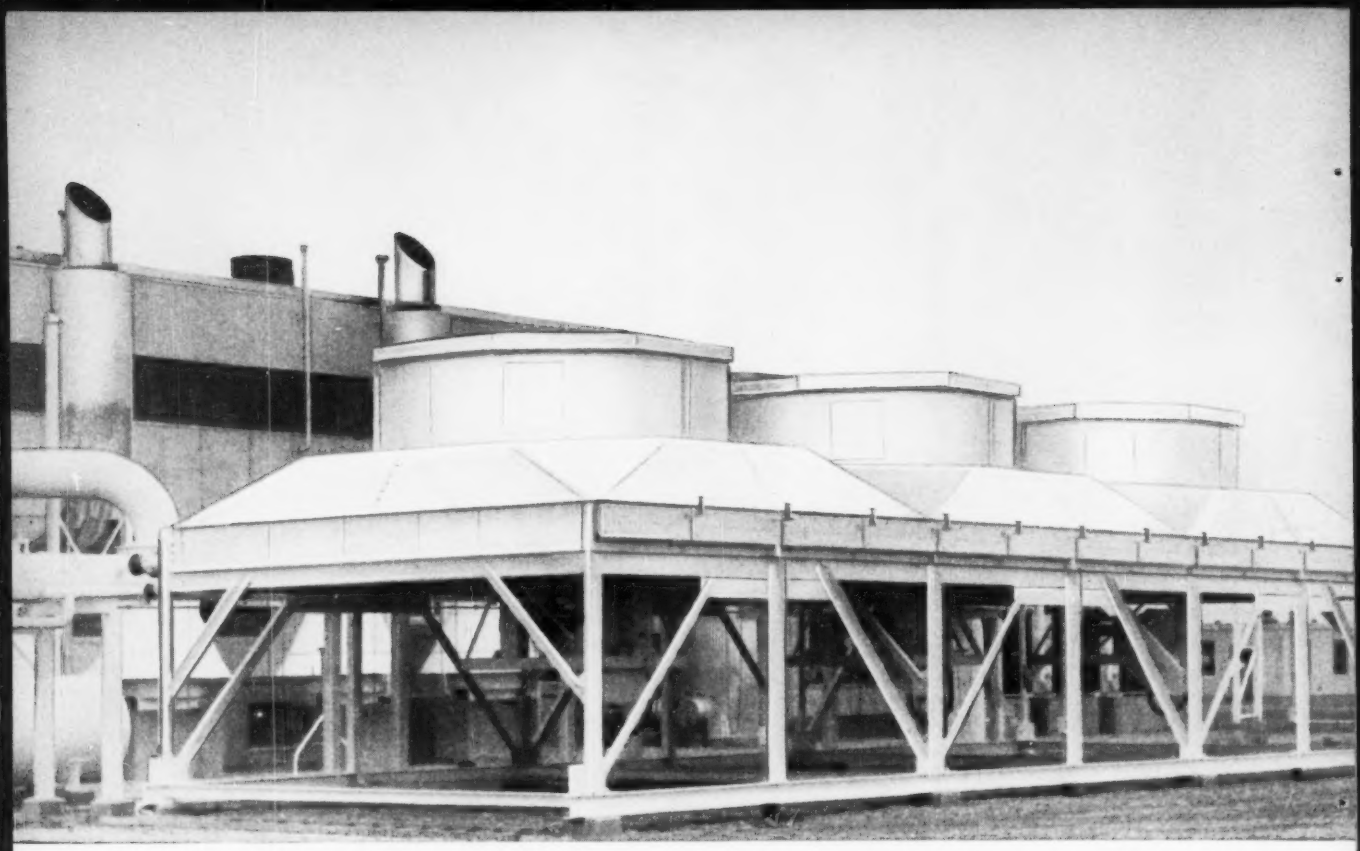
But . . . in many applications combinations of these factors exist. Or the liquid you want to pump is not clearly in either area. Then there are other considerations such as initial cost, operating cost, lubrication value of the liquid, location and even budget limitations.

All of these considerations can put you in the middle—where either a rotary or centrifugal can be used. The best choice can only be made by someone with experience and knowledge of both types.

As one of the few manufacturers of a complete line of both rotary and centrifugal pumps, Worthington can help you select the best, most economical solution to this perennial pump problem. For the name and address of your nearest Worthington representative, consult the yellow pages.

P.S. If you'd like a copy of a 50-page booklet, "Rotary and Centrifugal Pumps: Theory and Design," please write to Worthington Corporation, Section 20-14, Harrison, New Jersey, for bulletin G-2666.

WORTHINGTON



Giant compressor and generator engines are cooled by 26 TRANE Fluid Coolers at 6 Trans-Canada stations. Both horizontal and vertical air discharge types are used.

Trans-Canada, longest gas pipeline in the world, chooses Trane Fluid Coolers to cool engine water!

The Trans-Canada Pipeline System—2,294 miles long—provides market outlets for reserves of Alberta natural gas, serves Western Canada, and the great industrial areas of Eastern Canada.

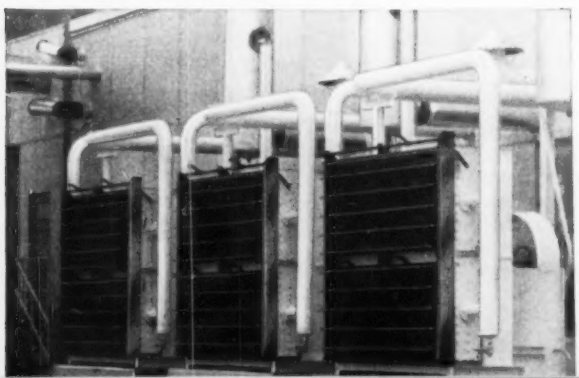
Because this pipeline passes through country where winter temperatures are very low, it was necessary to install engine jacket water cooling equipment that would function at 40 degrees below zero!

Trans-Canada chose TRANE Fluid Coolers for this important job. 26 TRANE units serve the initial six compressor stations. Air cooling was considered essential—and TRANE Fluid Coolers have shown that they can operate efficiently under all weather conditions.

More and more transmission companies are turning to TRANE for cooling equipment. Many have reported simplified maintenance, a minimum of adjustment problems. And engineers *know* that they can depend upon the accuracy and completeness of TRANE capacity ratings—tested in the industry's most complete laboratory, where as many as 90 different temperature readings are taken across the face of a heat transfer section!

When you have a fluid cooling problem, turn to TRANE! Just call your nearby TRANE Sales Office—or write TRANE, La Crosse, Wisconsin.

Small TRANE Horizontal Air Discharge Coolers cool the engines used to drive the 250-kilowatt generators (three per station) which supply electrical power on stations not served by a utility.

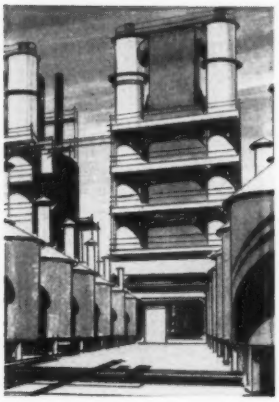
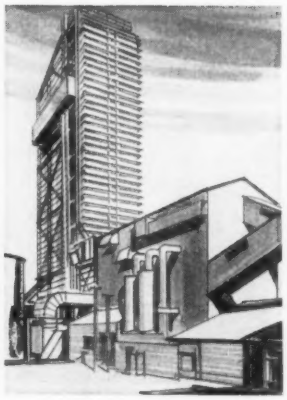
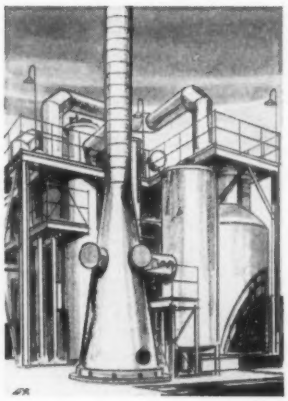
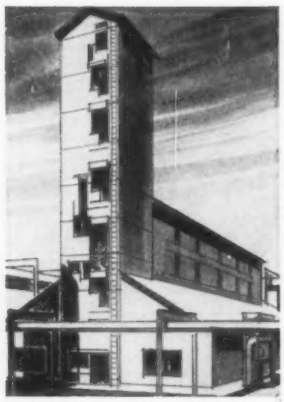


For any air condition, turn to

TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U. S. AND 19 CANADIAN OFFICES

Need tubes for heat exchangers, condensers, evaporators, coolers, feed-water units?

PHELPS DODGE COPPER-BASE ALLOY TUBES have a reputation for reliable "On-Stream" Performance!

■ Wide line of finest quality copper-base alloys for every kind of application need—including bi-metal combinations.

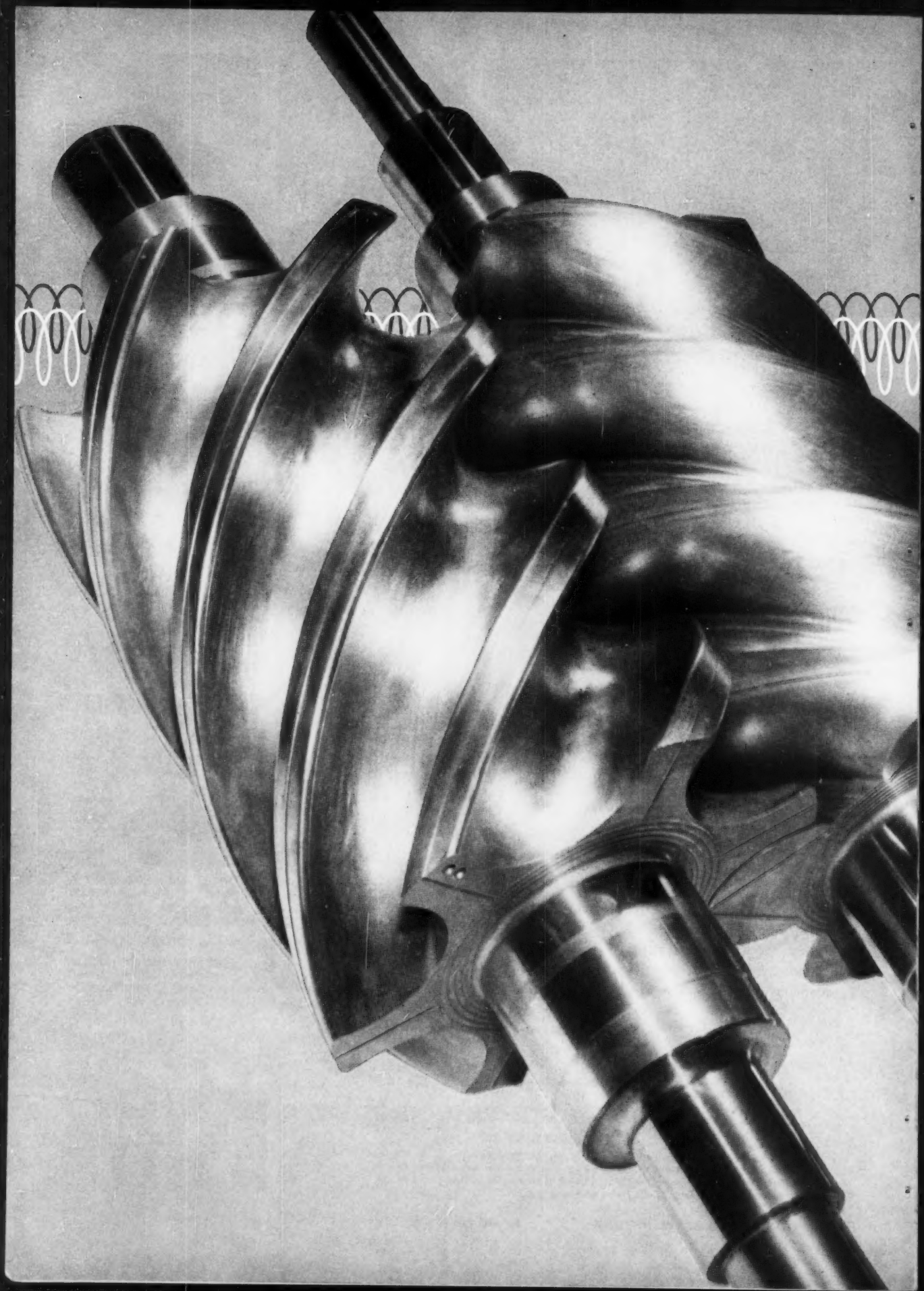
■ National warehouses, completely stocked, in Houston, Beaumont and Corpus Christi, Texas, Baton Rouge and Lake Charles, La., Tulsa, Los Angeles, and South Brunswick, N.J., to serve customers coast to coast.

■ Expert engineers to help you solve tube corrosion problems, select the exactly correct alloy for your applications.

Specify the best—at the same cost as the rest!

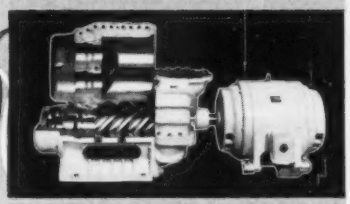
PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Denver, Detroit, Fort Wayne, Greensboro, N. C., Houston, Indianapolis, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Tampa, Washington, D. C.



NOW!

PROVED MECHANICAL SIMPLICITY TO REDUCE YOUR COSTS BY PREVENTING SHUT-DOWNS!



F-M ROTARY COMPRESSORS

FAIRBANKS-MORSE leadership shows again...with an advanced European concept to produce a truly unique aid-to-industry...our proved **AXIAL FLOW ROTARY COMPRESSOR** with Helical-shaped rotors! No reciprocating parts! No valves! No metal-to-metal contact provides maximum reliability...with high efficiency...at minimum costs!

- **HELICAL-SHAPED ROTORS . . . BY FAIRBANKS-MORSE**
  Smooth, economical compression with OIL-FREE delivery!
- **DEVELOPED IN SWEDEN! PROVED IN EUROPE! WIDELY USED IN U.S.A.!**
  Now—Fairbanks-Morse is in full production on our revolutionary Rotary Compressor . . . at our large Beloit, Wisconsin plant. The leaders of AMERICAN industry now use our Rotary Compressor . . . with PROVED results!
- **CAPACITY UP TO 21,000 CFM—PRESSURE UP TO 250 PSIG**
  . . . with a standard line of integrated frame sizes!
- **MECHANICAL SIMPLICITY! LOW MAINTENANCE REQUIREMENTS! HIGH EFFICIENCY!**
- **SMALL SPACE REQUIREMENTS—LOW WEIGHTS! MINIMUM VIBRATION!**
- **STABLE PERFORMANCE CHARACTERISTICS! SPEED FLEXIBILITY!**
- **FAMOUS FAIRBANKS-MORSE QUALITY!**
- **A VERSATILE ASSET TO MANY OPERATIONS!**

Our new Compressor is your logical choice for a wide variety of applications:

- Chemical and petrochemical process industries • Refinery process industries
- Heavy mass-production industries • Steel industry—coke oven gas compression
- Many other general purpose industrial and process uses.

Discover How The New F-M Rotary Compressor Can Step Up The Efficiency of YOUR Operations and Cut Down Maintenance Costs: Send for your copy of the New Fairbanks-Morse Compressor Bulletin Number ACO100.4.

Write to A. C. English, General Manager, Compressor Division
Fairbanks, Morse & Company
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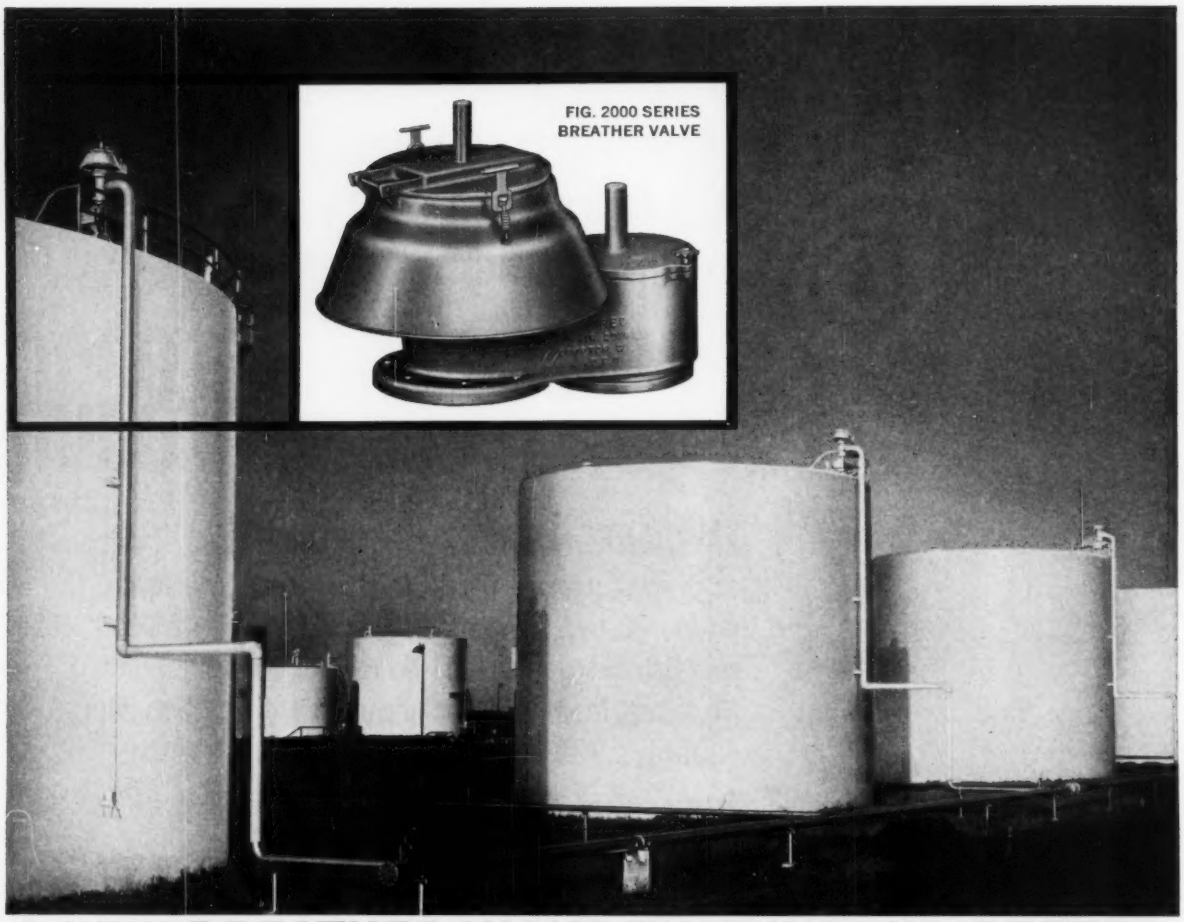
Compressor Division

A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY CORPORATION



A NEW BREATHER VALVE THAT WORKS BETTER, COSTS LESS, OFFERS MORE...

with easily accessible and interchangeable pallets

3-in-one valve flexibility . . . low-cost conversion

Varec's Fig. 2000 Series Breather Valve provides new built-in flexibility and efficiency . . . yet costs less to buy and maintain. It offers choice of any one of three pallet designs—air cushion, diaphragm, or metal-to-metal. It converts, to meet your changing needs, into any of these designs without adapter kit . . . just by replacing pallets. The pressure and vacuum pallets of each valve are interchangeable, cutting maintenance problems.

Quick opening covers . . . fast, easy inspection

Two separate opening covers permit fast, independent access to either the pressure or vacuum pallet. Total cover opening averages 5 seconds per valve. The covers have no loose parts that can be lost. Replacements for air cushion or diaphragm pallets can be made in two to three minutes.

Better design for improved performance

This new Varec valve is better-built—with many quality anodized parts and protective port screens. It weighs 50% less than older models. Drip rings on pallets keep moisture away from seating surfaces, and the hyperbolic design greatly reduces "blow down," which results in vapor savings. Both air cushion and diaphragm pallets have inner layers built in for added protection.

For complete information on the Varec Fig. 2000 Series Breather Valve, write for Varec Bulletin No. CP-2701, Dept. PR-1400-1.

"Varec"
TRADE ® MARK

THE VAPOR RECOVERY SYSTEMS COMPANY
2820 North Alameda Street • Compton, California

Branches and Representatives in Principal Cities.

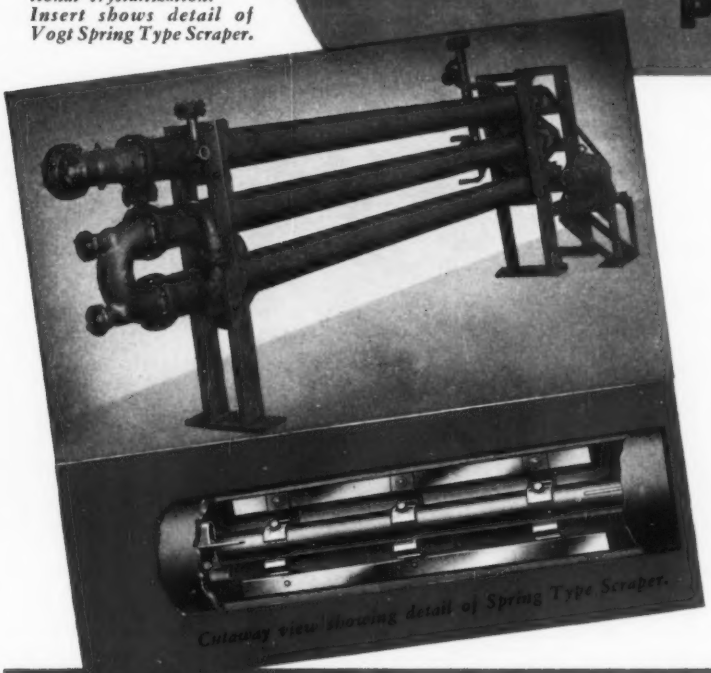
For more data on advertised products, use Readers' Service Cards, last page.

Vogt

SCRAPED SURFACE EXCHANGERS

Solve those Special Heat Transfer and Crystallization Problems . . .

BELOW: *A scraped surface unit for production of Para-Xylene by fractional crystallization. Insert shows detail of Vogt Spring Type Scraper.*



Cutaway view showing detail of Spring Type Scraper.

. . . *And Here's How:*

1. Rotating scraper action continuously sweeps surfaces clean even while processing highly adhesive materials.
2. Uniform rate of heat transfer keeps crystallization under control and discharges crystals as a slurry.
3. Product is thoroughly mixed by scraper blades as it flows.
4. Closed, pressure-type system permits use of flammable, volatile and expensive solvents with complete safety and no solvent loss.
5. Units fabricated from a broad range of materials to suit process stream characteristics.

Write for Literature. Address Dept. 24A-XPR

Listed here is a wide variety of materials which have been successfully processed with Vogt Scraped Surface Exchangers in the chemical, petro-chemical, petroleum and related industries.

- Benzene Hexachloride
- Caustic Soda
- Caustic Potash
- Clay
- Cylinder Stock
- Para-Dichlorbenzene
- Fatty Acid Solutions
- Fish Oil
- Linseed Oil
- Naphthalene
- Paratone & Solids
- Phenolic Resins
- Polyester Liquid
- Pressed Distillate
- Reduced Petroleum
- Waxy Oil-Solvent Mix
- Soybean Oil
- Sperm Oil
- Sugar Syrup
- Sulfur-Oil Mix
- Sulphate Solution
- Tall Oil-Naphtha-Sulfuric Acid Solutions
- Tetrachloro Benzene
- Viscose
- Wax Slurry
- Para-Xylene

HENRY VOGT MACHINE CO.
Louisville 10, Ky.

SALES OFFICES:
New York, Chicago, Cleveland, Dallas, Camden, N.J., St. Louis, Charleston, W.Va., Los Angeles

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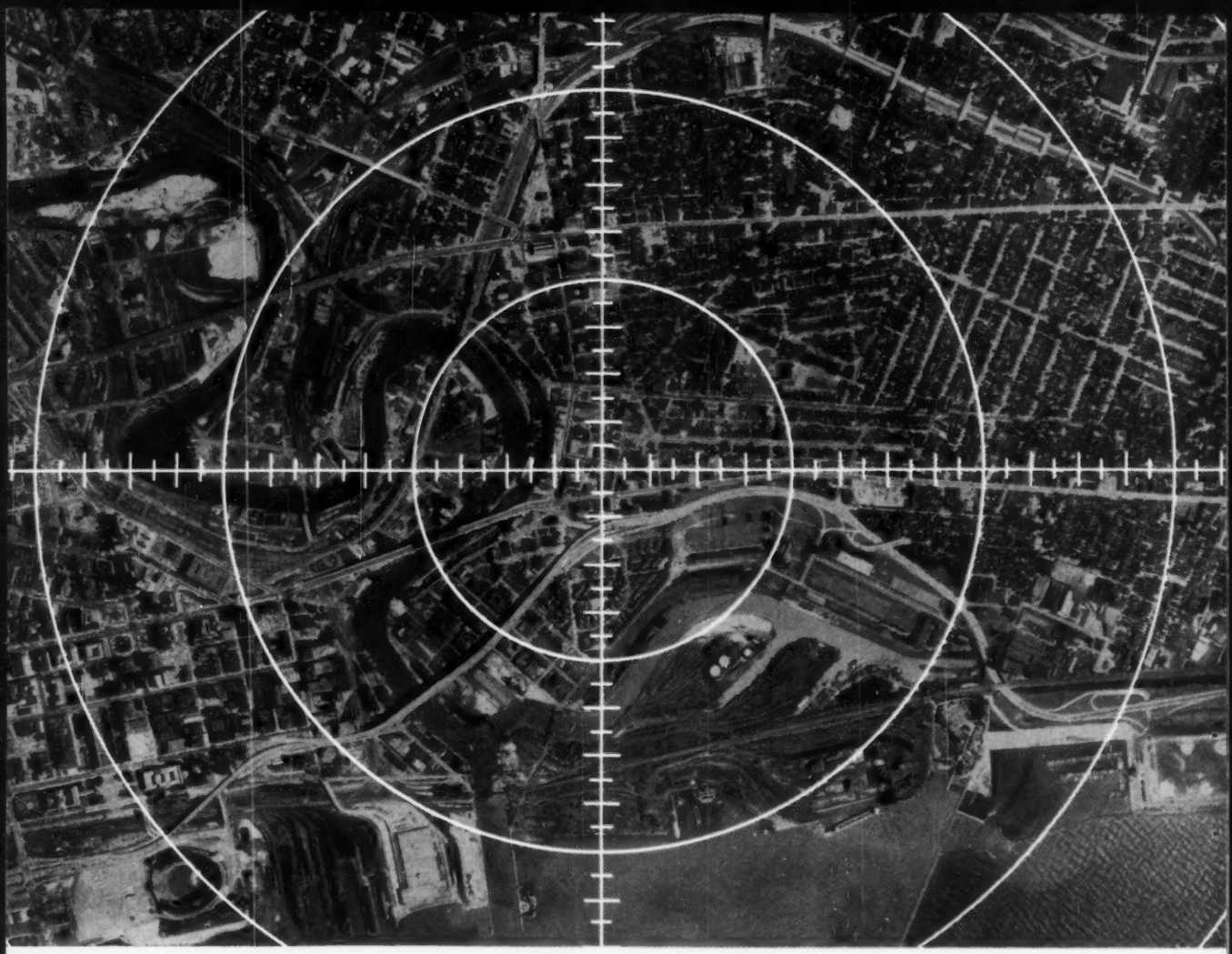

INDUSTRIAL METROPOLIS...

of plants designed and built by McKee

IN operation throughout the United States, and in some thirty-five other countries around the world, are hundreds of projects designed and built by McKee. If all of these blast-furnaces, open-hearth shops, sintering plants, pelletizing plants, petroleum refineries, chemical plants and related facilities completed by McKee were located in one city they would form an industrial metropolis much larger than that illustrated above.

These plants represent an investment by our customers of well over one-and-a-half billion dollars. But they represent much more than that—our world-wide experience, specialized engineering and construction services, an organization staffed and equipped to do the job—*anywhere*. Most important, they represent the confidence of the Petroleum, Chemical and Steel Industries in McKee's ability to design and build profit-making plants. We will welcome an opportunity to show you how McKee can apply this ability for you.

ARTHUR G. McKEE & COMPANY • 2300 Chester Avenue • Cleveland 1, Ohio

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McKEE ENGINEERING AND CONSTRUCTION SERVICES

CHEMICAL USERS' GUIDE

To General Chemical Products for the Petroleum Industry

Product	Available Forms	Commercial Strengths	Shipping Containers	Applications
Sulfuric Acid H_2SO_4 + Water	Liquid	66° Be (93.2% H_2SO_4) 99% H_2SO_4	Carboys Tank Trucks Tank Cars Tank Barges	Alkylation and sulfonation.
Oleum $H_2SO_4 + SO_3$	Liquid	15% SO_3 (103.4% H_2SO_4) 20% SO_3 (104.5% H_2SO_4) 65% SO_3 (114.6% H_2SO_4)	Drums Tank Trucks Tank Cars Tank Barges	Sulfonation.
Sulfan® Stabilized SO_3	Liquid	99.5% SO_3	Drums Tank Cars	Sulfonation.
Hydrofluoric Acid, Anhyd. HF	Liquid	99% HF	Cylinders Tank Cars	Alkylation.
Muriatic Acid HCl + Water	Liquid	18°, 20°, 22° Be (27.4% to 34.1% HCl)	Carboys Tank Trucks Tank Cars	Acidizing and isomerization.
Fluosulfonic Acid HSO_3F + Water	Liquid	98% HSO_3F	Drums Tank Cars	Alkylation and polymerization.
Boron Trifluoride	Gas	99% BF_3	Cylinders	Alkylation and polymerization.
Boron Trifluoride	Liquid	48% BF_3	Drums Tank Trucks Tank Cars	Alkylation and polymerization.
Boron Trifluoride	Liquid	26% BF_3	Drums Tank Cars	Alkylation and polymerization.
Sodium Metasilicate, Crystal $Na_2SiO_3 \cdot 5H_2O$	White Granules	29.0% Na_2O	Bags Fibre Drums	Detergents.
Sodium Metasilicate, Anhyd. Na_2SiO_3	White Granules Powder	50.5% Na_2O	Bags Fibre Drums	Detergents.
Sodium Silicate $Na_2O \cdot XSiO_2$ + Water	Liquid	38° to 60° Be Various ratios of Na_2O to SiO_2	Drums Tank Trucks Tank Cars	Mud conditioning.
Sodium Sulfate, Anhyd. Na_2SO_4	White Granules	99.8% Na_2SO_4	Bags Bulk Carloads	Detergents.
Disodium Phosphate, Anhyd. Na_2HPO_4	Powder Flake	48% P_2O_5	Paper Bags Fibre Drums	Detergents and mud conditioning.
Trisodium Phosphate $Na_3PO_4 \cdot 12H_2O$ *(TSP)*	Crystal	18.4% P_2O_5	Paper Bags Fibre Drums	Detergents and mud conditioning.
Tetrasodium Pyrophosphate, Anhyd. $Na_4P_2O_7$ *(TSPP) (Pyro)*	White Granules	52.1% P_2O_5	Paper Bags Fibre Drums	Detergents and mud conditioning.
Sodium Tripolyphosphate $Na_5P_3O_{10}$ *(Tripoly)*	White Granules	56% P_2O_5	Paper Bags Fibre Drums	Detergents and mud conditioning.

The products advertised are commercial chemicals having various uses, some of which may be covered by patents, and the user must accept full responsibility for compliance therewith.

Basic to America's Progress

Allied Chemical

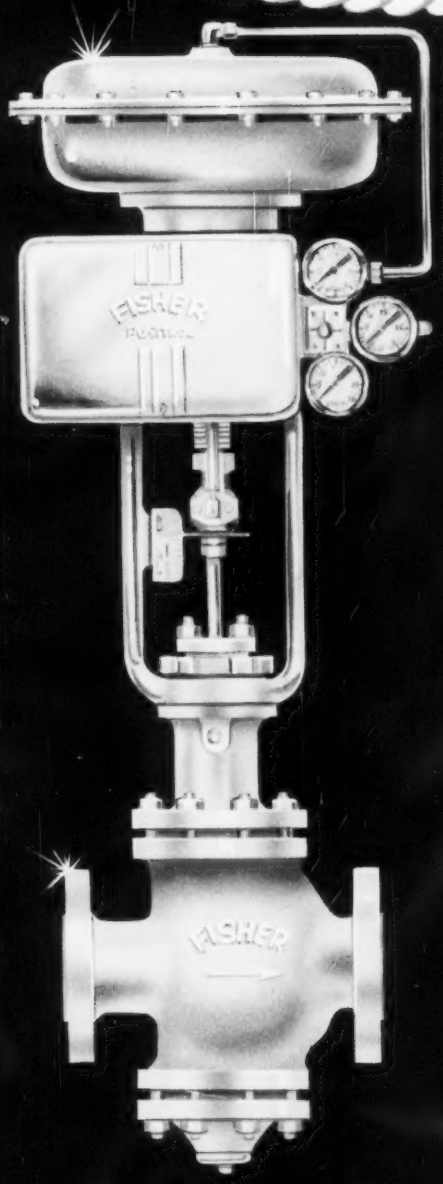
OTHER PRODUCTS: Aluminum Sulfate (Standard and Iron Free); Aqua Ammonia; Cuprous Chloride; Nitric Acid; Potassium Nitrite; Sodium Fluoride; Sodium Bifluoride; Hydrofluoric Acid (Aqueous); Phosphoric Acid, Com'l. **CATALYSTS AND SPECIAL CHEMICALS:** Companies requiring catalysts, addition agents, inhibitors, or other special chemicals "tailor-made" for their individual processes are invited to consult with General Chemical on their requirements. The same progressive research, technological "know-how", and practical experience that has found the answer to so many petroleum chemical problems during General's long service to the Industry may help provide the solution to yours, too.

FOR THE LABORATORY OR SPECIAL APPLICATIONS: BAKER & ADAMSON® REAGENTS and FINE CHEMICALS

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

. . . not even 24k GOLD . . .



why you can depend on

FISHER CONTROL VALVES

24 hours a day –every day. . .

. . . *could increase the value of a* FISHER DMV!

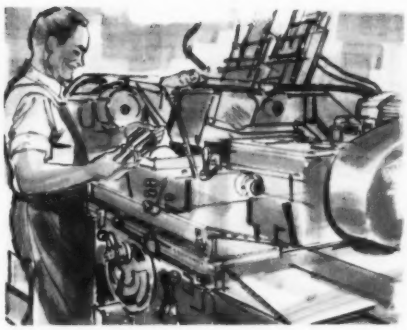
Why? Simply because the *real* value of Fisher diaphragm motor valves lies, not in metal and fiber and paint. It lies in practical design, improved manufacturing techniques, rigid inspection and a field organization second to none.

These are the factors that represent your real assurance of trouble-free performance in Fisher control equipment. They are also the factors that have made Fisher control valves the standard throughout industry for nearly half a century.

Next time you need control valves give the Fisher/Man a call. He's conveniently located for service and you'll find he has what you want . . . and where you want it . . . in a hurry.

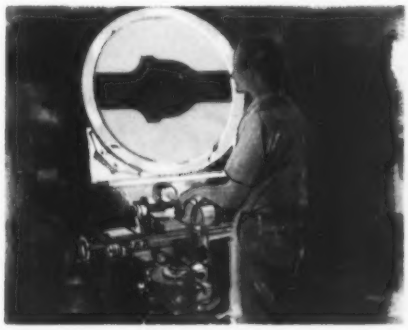
PRACTICAL DESIGN ENGINEERING

Design Engineering at Fisher is always aimed at solving industry's flow control problems in a practical and efficient manner. Continuous improvement for more than 50 years has resulted in a series of Fisher Diaphragm Motor Valves of proven durability and performance.



LATEST PRODUCTION METHODS

This machine, the latest in precision grinders, produces a super-finish on all valve guides and bushings. It is just one example of combining modern machine tools and the skill of experienced Fisher craftsmen to assure accuracy of control and long, trouble-free field operation.



RIGID INSPECTION PROCEDURES

Fisher's ratio of inspection personnel to production personnel has always been considered highest in the industry. This makes possible Fisher's rigid inspection policies. For example, no less than 704 inspection operations are performed on a 4" Type 657A control valve.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / Rochester, England

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIP. CO., CORAOPOLIS, PA.

FISHER® Controls

SINCE 1880

to all NATURAL GASOLINE MEN

GREETINGS

from the

NATURAL GASOLINE SUPPLY MEN'S ASSOCIATION

We are looking forward to seeing you at the
FORTIETH ANNUAL CONVENTION
of the NATURAL GASOLINE ASSOCIATION OF AMERICA
MARCH 15-17, 1961 BAKER HOTEL, DALLAS, TEXAS

Members of the Natural Gasoline Supply Men's Association

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Oil Well Supply Div.—U.S. Steel Corp.
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Taylor Forge & Pipe Works
Taylor Instrument Companies
Tellepsen Petro-Chem Constructors
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Thurmond-McGlothlin

Union Pump Sales Company
United Centrifugal Pumps
United Chemical Corporation of New Mexico
Universal Oil Products Co.

Vinson Supply Company
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Weatherby Engineering Co.
Wesco Valve Co., Inc.
Western Chemical & Supply Co.
Western Chemical Co. of K.C., Mo.
Western Industrial Supply Co.
Western Industries, Inc.
Western Supply Company
Charles Wheatley Company
The Wickes Boiler Company
Wilson Supply Company, Compressor Division
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York Corporation, Subsidiary of Borg-Warner Corp.
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For more data on advertised products, use Readers' Service Cards, last page.

S&L

CALL ON S & L FOR

WELDING FITTINGS

Stocks of S & L seamless steel welding fittings are held at our works ready for despatch to all parts of the world.

Stewarts and Lloyds mine iron ore and produce the steel from which their pipes are made. They are thus able to exercise detailed quality control during all stages of manufacture from the raw material to finished product.

S & L — a name synonymous with high quality.

Specify S & L for your next project.

STEWARTS AND LLOYDS LIMITED

'O' Department,
8 Gough Square, Fleet Street,
London, E.C.4, England
Cable: Lapweld London Telex

For more data on advertised products, use Readers' Service Cards, last page.

Photographed at DX Sunray Oil Company, (Tulsa Refinery)

For a higher yield per dollar—Aerocat Triple A

Why more and more refineries are increasing efficiency and cutting costs with this 25% Alumina Catalyst. AEROCAT TRIPLE A® Cracking Catalyst, the first commercially successful 25% alumina catalyst, is still setting records. Its combination of extremely high activity and unusual stability provide premium cracking efficiency, high equilibrium activity, increased conversion at lower temperatures, or (compared to conventional, low alumina catalysts) reduced catalyst usage at severity levels.

Yet, with all its efficiency, AEROCAT TRIPLE A can actually save you money, compared to other synthetics of comparable performance—particularly where low catalyst turnover is possible. It yields *more* gasoline; it measurably increases octane rating, and with no increase in stack losses of the catalyst itself. The increased output takes place at the expense of a lower dry gas yield.

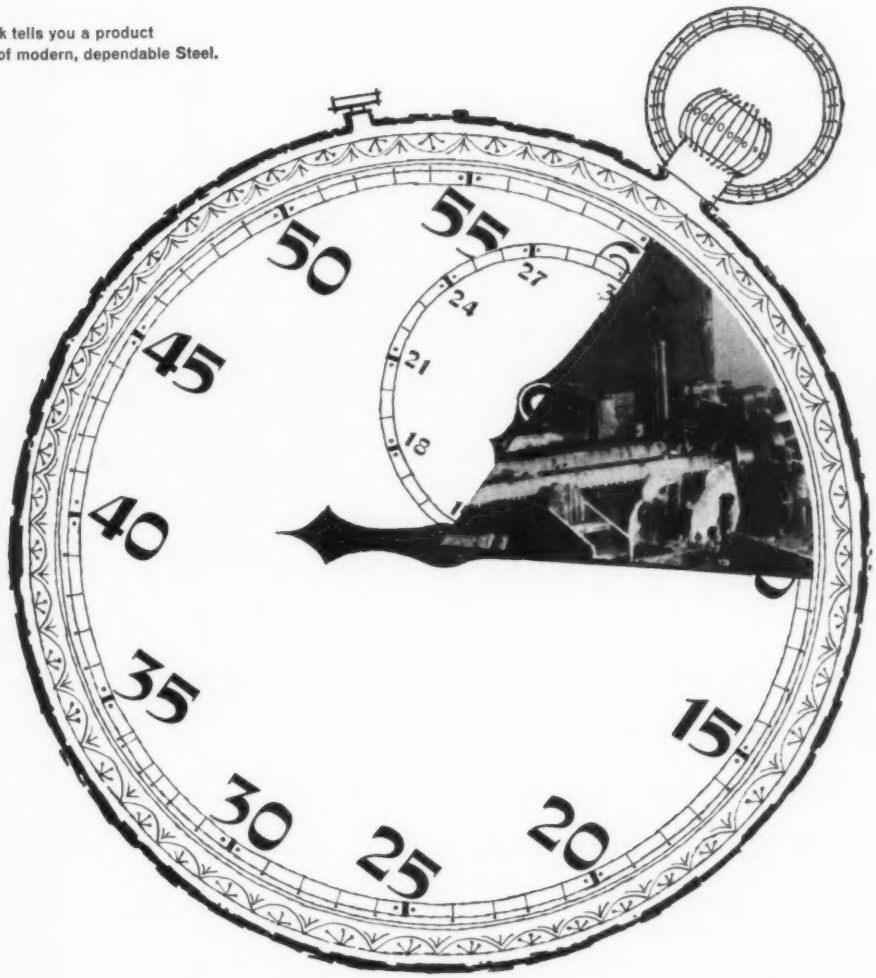
Isn't it time you investigated what AEROCAT TRIPLE A can do for *you?* Your Cyanamid salesman—"The Man with the Golden Rule"—will be glad to cooperate, for sharing his skill and experience with refiners is a most important part of his job. Why not call him *now?*

Basic in catalyst chemistry

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT • 30 Rockefeller Plaza, New York 20, New York

This mark tells you a product
is made of modern, dependable Steel.



The ten most important seconds in the life of a pressure tube

Every length of USS National Electric-Resistance Welded Pressure Tube must pass a hydrostatic pressure test before it leaves our mill.

Each tube is fitted in leakproof heads and filled with water treated with a corrosion inhibitor. After all air is purged, pressure is applied and held for ten seconds. Internal hydrostatic pressure varies with size as prescribed by applicable ASTM specifications which are designed to produce a wall stress from 16,000 to 24,000 psi. Typical pressures so calculated are 4,000 psi for 1″ O.D. x .085″ wall and 2,100 psi for 3″ O.D. x .134″ wall.

Our rigid inspection of each pressure tube promises long efficient service in boilers, heat exchangers, condensers, super-heaters, economizers and other pressure applications.

For your next installation, consider USS National Electric-Welded Pressure Tubes. They are stocked all over the country by National Tube Distributors. Our trained Mill Service Force is also available for field consultation. Write National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS and National are registered trademarks

National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division • United States Steel Export Company, New York

For more data on advertised products, use Readers' Service Cards, last page.

NEW

CLAYTON MARK

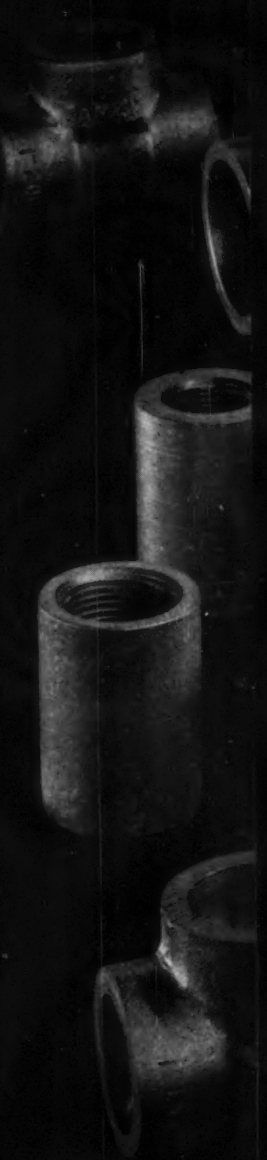
Parkerized

FITTINGS

- **RUST PROOF, CORROSION-RESISTANT**
- **CARBON AND ALLOY**
- **SCREWED AND SOCKET WELD**
- **2000, 3000, 4000, 6000 p.s.i.**

Now you can buy a complete line of *Parkerized* Fittings from the same source that has supplied you with high pressure Unions and Valves since 1912. In sizes $\frac{1}{8}$" to 4", these forged steel, clean-looking fittings resist corrosion "forever" on shelf or in high-pressure steam, water, oil, gas and air applications. Eliminate duplicate paperwork . . . order all your piping requirements from your Clayton Mark Distributor. Have the best yet save time and money —specify Clayton Mark!

AVAILABLE IN 50 STATES AND THROUGHOUT THE WORLD



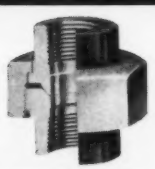
CLAYTON MARK

AND COMPANY

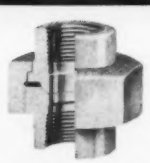
1914 DEMPSTER STREET · EVANSTON, ILLINOIS · U.S.A.

PUMPS · WATER WELL SUPPLIES · CONDUIT · UNIONS · TUBING

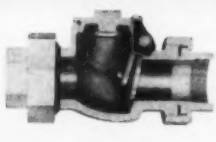
HOT FORGED STEEL HIGH-PRESSURE UNIONS AND VALVES



"PETRO" CARBON STEEL UNION



PETRO" STAINLESS STEEL UNION



SWING CHECK VALVE

"PETRO" CHECK VALVE

"BEVELED" ORIFICE UNION

ENGELHARD

standard or custom PRECIOUS METAL CATALYSTS for use in the organic and petroleum chemical industries

Engelhard PRECIOUS METAL CATALYSTS are available...on a wide variety of carriers ...in the form best suited for your needs...in the concentration most economical for your purpose

ENGELHARD'S MOST WIDELY USED SPECIES

	ALUMINA-SUPPORTED CATALYSTS
5%	Pt, Pd, or Rh on alumina powder
0.5%	Pt, Pd, Rh, or Ru on alumina pellets or spheres
0.3%	Pt on alumina pellets or spheres
	RD 150 or RD 150C

	CARBON-SUPPORTED CATALYSTS
5%	Pt or Pd on activated carbon powder
5%	Rh or Ru on activated carbon powder
0.2%	Pd on granular carbon

	OTHER CATALYST SPECIES
5%	Pd on $CaCO_3$ or $BaSO_4$ powder
	Pd or Pt oxide
	Pd or Pt black

For efficiency in promoting various laboratory chemical reactions and in large scale reactions including fabrication of rocket fuels, plastics and textile intermediates, high octane gasoline, heavy chemicals and fine pharmaceuticals, *consult with the Chemical Division of* ENGELHARD INDUSTRIES, INC. *where the world's largest research and production facilities* in the field of PRECIOUS METAL CATALYSTS are combined *to meet your requirements.*

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SALES OFFICES THROUGHOUT THE WORLD.

LEADERS IN MANUFACTURING AND REFINING OF PRECIOUS METALS CATALYSTS FOR OVER THIRTY YEARS

Here's Why Oil Men Specify
EC&M HIGH VOLTAGE STARTERS

2200-4800 Volts
Totally Oil-Immersed

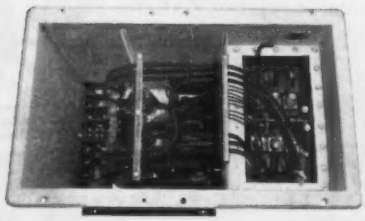
EC&M Type ZHS Starters at Southwestern pipe line trunk station

Designed for Easier Installation, Inspection and Maintenance

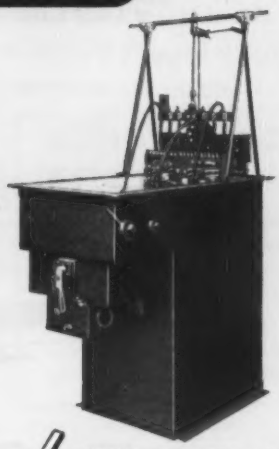
Specifically designed for Class I, Group D, Division 2, semi-hazardous locations . . . NEMA 3R (raintight enclosure). 50,000 KVA interrupting capacity.

***Fast* Installation** because starters are shipped with all internal wiring complete. All leads are of anti-syphon construction.

Easy Inspection • Contactor and overload relay panel may be raised, as one unit, above oil level. No disconnecting of bolts or leads. *(See lifting mechanism at extreme right.)* Safer, too . . . note view windows on each side of load-break disconnect switch.



View from above shows complete internal wiring . . . anti-syphon leads. These "ready-to-use" starters are complete with control transformer for 220 volt push button operation.



EC&M Contactor lifter raises contactor and overload relay above oil level for easy inspection. No bolts or leads to disconnect.

For literature describing EC&M's complete starter line, write for Bulletin 8131-T

SQUARE D COMPANY

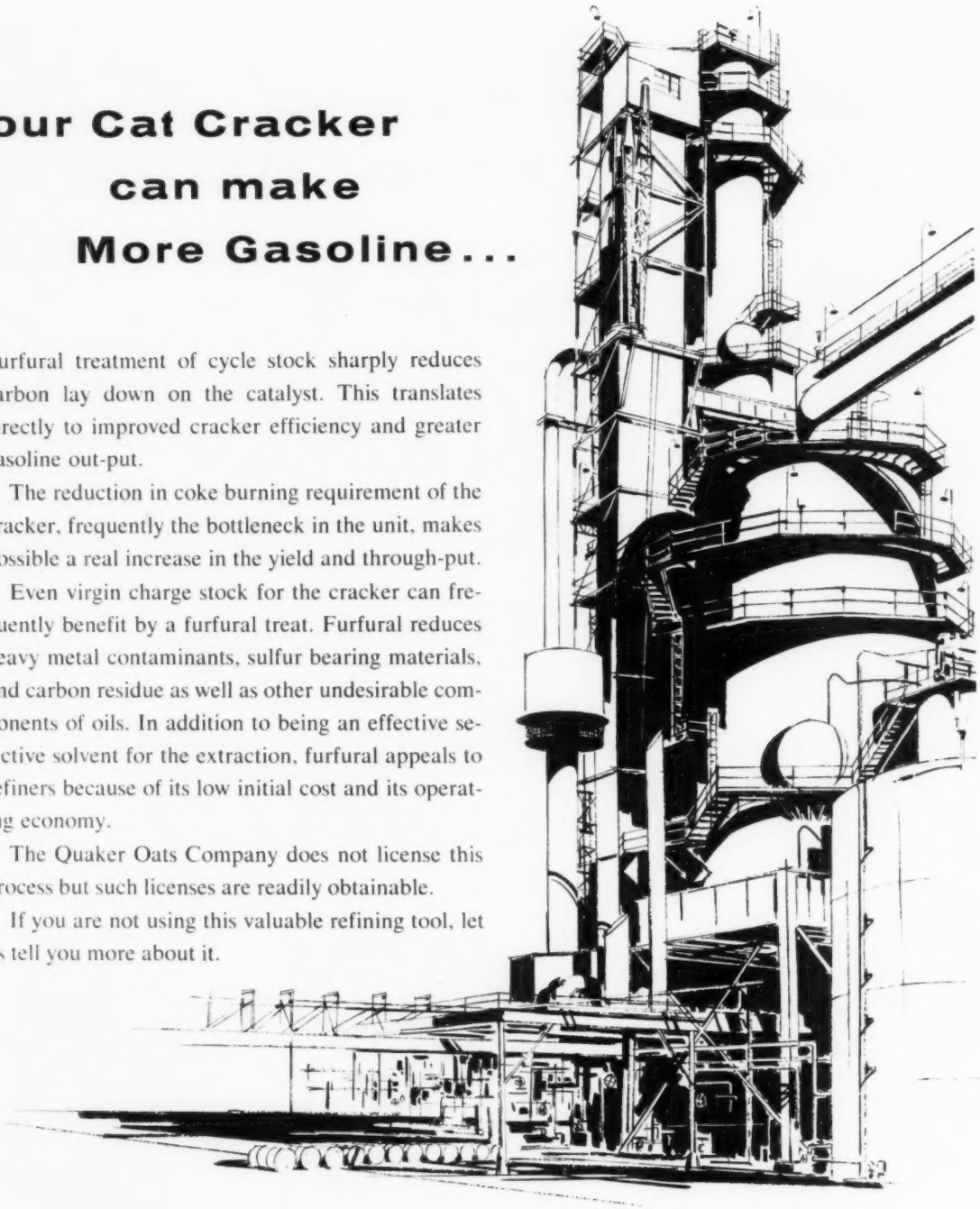
EC&M DIVISION • CLEVELAND 28, OHIO

wherever electricity is distributed and controlled

8020

For more data on advertised products, use Readers' Service Cards, last page.

Your Cat Cracker can make More Gasoline...



Furfural treatment of cycle stock sharply reduces carbon lay down on the catalyst. This translates directly to improved cracker efficiency and greater gasoline out-put.

The reduction in coke burning requirement of the cracker, frequently the bottleneck in the unit, makes possible a real increase in the yield and through-put.

Even virgin charge stock for the cracker can frequently benefit by a furfural treat. Furfural reduces heavy metal contaminants, sulfur bearing materials, and carbon residue as well as other undesirable components of oils. In addition to being an effective selective solvent for the extraction, furfural appeals to refiners because of its low initial cost and its operating economy.

The Quaker Oats Company does not license this process but such licenses are readily obtainable.

If you are not using this valuable refining tool, let us tell you more about it.

The Quaker Oats Company

CHEMICALS DIVISION

The Quaker Oats Company — Chemicals Division — QO Furan Chemicals

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Room 540S, 120 Wall St.,
New York 5, N. Y.

Room 440S, 48 S.E. Hawthorne Blvd.
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In the United Kingdom:
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In Europe:
Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands;
Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France;
A/S "Ota", Copenhagen, S. Denmark

In Australia:
Swift & Company, Ltd., Sydney

In Japan:
F. Kanematsu & Company, Ltd., Tokyo

For more data on advertised products, use Readers' Service Cards, last page.

HOKE Flow Sheet 3

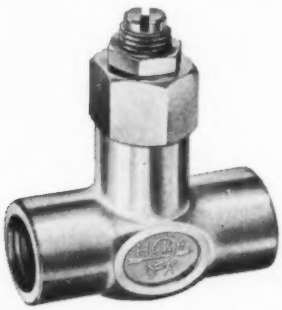
HOKE REPORTS ON FLUID CONTROL

WE'VE TOSSED A NEW BALL INTO AN OLD GAME

How Do You Gauge Protection?

Not that we're trying to put an end to our pressure gauge business, but the new Hoke gauge protector will save you quite a bit of money on gauge repairs and replacement. It will help soothe the savage temper of your maintenance man, which might be even more important.

The new 530 Series gauge protector prevents sudden pressure surges from damaging costly gauges. Mounted conveniently, and directly between the pressure source and the gauge, it can be set for any pressure protection point between 30 and 1000 psig and will handle inlet pressures to 3000 psig. Minimum burst pressure is 9000 psig, so you have a



good safety margin. Its widespread popularity among maintenance men is due to the fact that it does not have to be re-set when the pressure drops below the protection point.

Those more interested in technicalities should read this: The temperature range is −10° to +200° F, and the unit is usable in any clean gaseous service compatible with brass and Buna-N. It weighs only 5¼ ounces, and measures 1⅞ inches from inlet to outlet. Both ends are ¼ NPT female connections, so no adaptors or connectors are necessary for installation.

Specs are available, whatever your reason for wanting them—Write!

SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE

The technique of molding polyvinyl chloride into ball valve parts is old hat. Even the unplasticized compounds of type I PVC have been kicked around for a while (with minor successes). But until now, no one has booted the ball for a goal.

Perseverance, determination, and the pursuit of economic reward have prompted us to offer a line of ball valves molded of the toughest grade of type I, unplasticized PVC. There are no foreign agents to contribute to a corrosive demise, even in most caustic services. It even meets the proposed new ASTM specification and has a tensile strength of 8500 psi. Those who have had PVC piping problems will profit from the new molding process that gives these Hokes dimensional stability and very high impact strength. Sensitive systems, human and otherwise, are safe from contamination—they're absolutely non-toxic. We've set 140°F. as the operating temperature limit, but occasional excursions to 160°F. won't do any harm.

All standard models are supplied with a concentric hole drilled thru the ball. They can be heat welded, or solvent bonded right in the line. Piping hook-up is even simplified by their coupling-like assembly. Your assistant can fit each half of the valve to a pipe end, then reassemble the valve without having to turn the pipe. Pressures to 125 psi are duck soup for these valves.

A maintenance man's delight, they can be cleaned and have their seats changed without leaving the pipe. Their light weight makes them ideal for use on long, unsupported spans of pipe.

Size-wise, we're offering them in ½, ¾, 1, 1½, 2, and 3 inch sizes, all NPT female connections.

You will command the eternal admiration of your colleagues when you install these valves. Be the first to show your rightful status by ordering a shiny new Hoke polyvinyl chloride ball valve. If pride of ownership hasn't motivated you at this point, the mere fact that you are behind the scientific times should move you to find out more.

It isn't necessary to tell us why you want the additional information. Just check the coupon below. We'll forward the facts in a plain, brown envelope.

WHAT'S NEW FROM HOKE?

Lots of things have been happening at Hoke. To be sure you're up to date on these developments in fluid control see your nearest distributor. He'll have something new for you every other month this year.

Hoke's Performance Guarantee — *Every Valve Leak-Tested!*

HOKE, INCORPORATED
167 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

- ☐ PVC Ball Valves
- ☐ 530 Gauge Protectors
- ☐ Flow Sheet
- ☐ "What's New"
- ☐ Complete Catalog GC 960

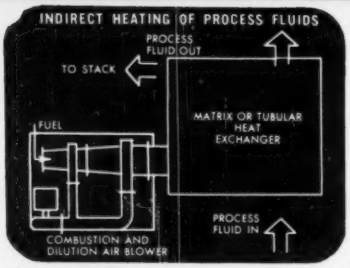
NAME _____ TITLE _____

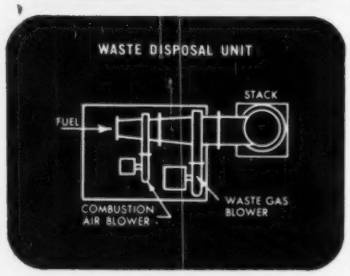
COMPANY _____

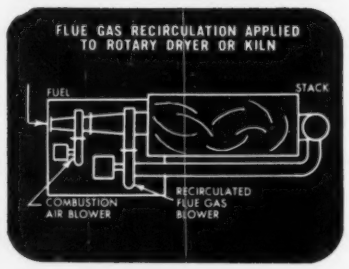
ADDRESS _____

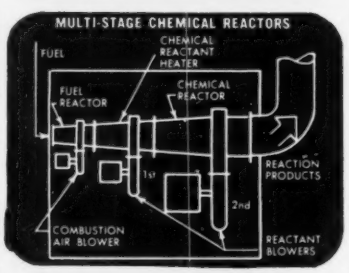
CITY _____ STATE _____

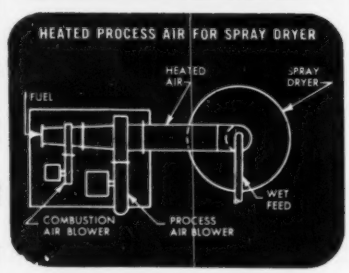
For more data on advertised products, use Readers' Service Cards, last page.

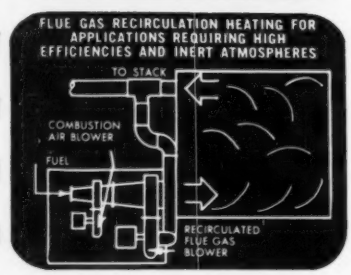






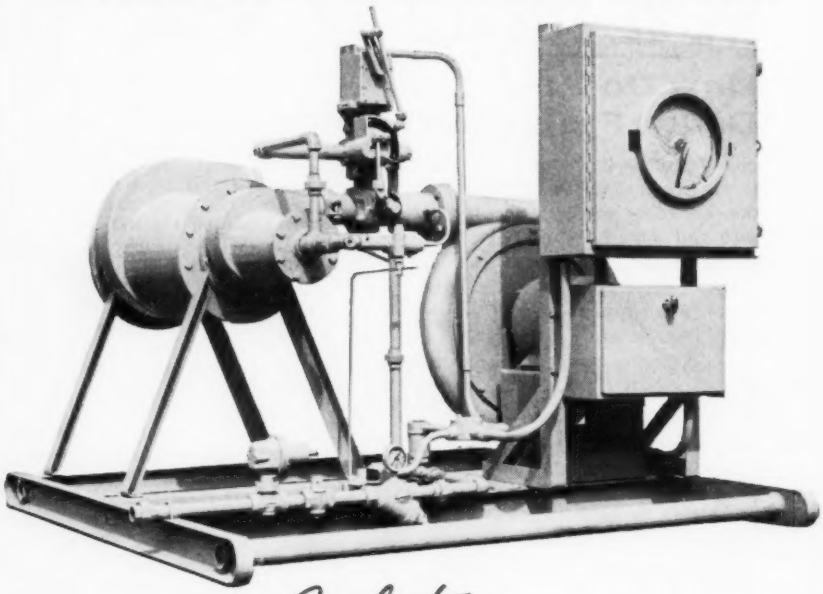





FLUE GAS RECIRCULATION HEATING FOR APPLICATIONS REQUIRING HIGH EFFICIENCIES AND INERT ATMOSPHERES
TO STACK
COMBUSTION AIR BLOWER
FUEL
RECIRCULATED FLUE GAS BLOWER

BS&B Q-PAK

PACKAGED DIRECT-FIRED HEATERS



The ~~Hottest~~ Coolest Thing in Heaters

HERE'S WHY:

- High heat release, rates up to 10,000,000 BTU/Hr. per cubic foot of combustion volume.
- "Q"-PAK needs no refractory lining even at temperatures of 3000° F. outlet, because outer surfaces are air cooled.
- This completely sealed unit is safe for use in fire hazardous areas.
- Flame stability over a wide range of air to fuel ratios . . . No flame flashback . . . No flame extension . . . Designed to give maximum protection against loss of flame due to overfiring.
- High intensity mixing assures complete combustion: hence produces clean, hot air or gas . . . Provides inert gas generation if required.
- "Q"-PAK operates under vacuum, atmospheric or high pressure situations.
- Burns low pressure, very low BTU content fuels and heats to maximum in minutes (even seconds) from a cold start.
- Completely packaged unit—ready for immediate operation.

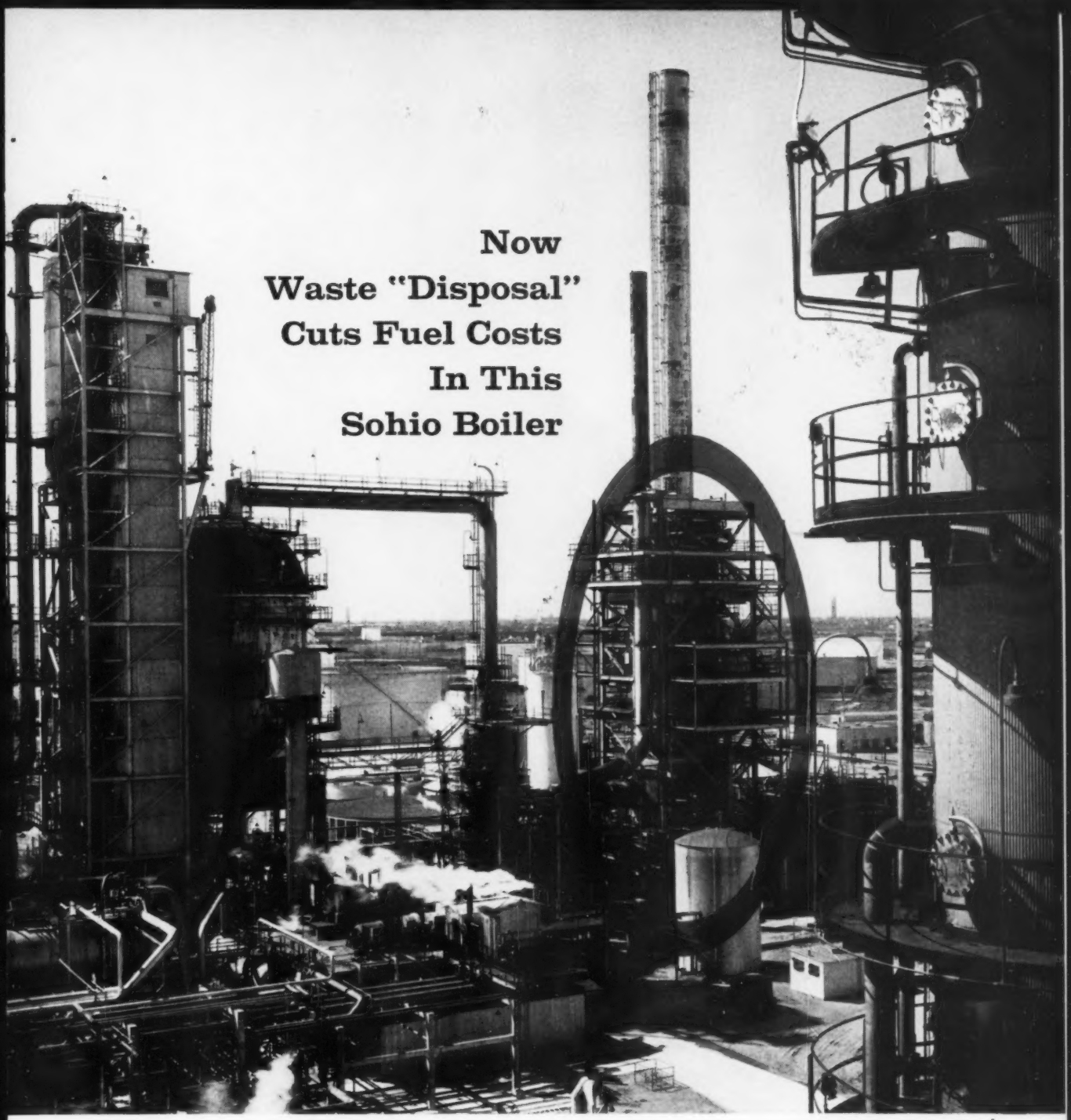
That's why we say it is the coolest development in heaters. Just a few of the hundreds of applications are shown here . . . why not find out where "Q"-PAK fits into your process and how it can work for you?

Write to Black, Sivalls & Bryson, Inc., Dept. 1-F2 7500 East 12th St., Kansas City, Missouri.

BSB

BLACK, SIVALLS & BRYSON

KANSAS CITY • TULSA • OKLAHOMA CITY • EDMONTON • LONDON • PARIS • THE HAGUE



Now Waste "Disposal" Cuts Fuel Costs In This Sohio Boiler

Firing low Btu carbon-monoxide gases—once disposed of as unusable waste—in this B&W CO® Boiler cuts fuel costs for Sohio's Toledo refinery. Using refinery gas and CO gas together, the boiler will provide up to 450,000 lb of steam hourly meeting 100% of the refinery's steam requirements. Steam conditions are 625 psi and 750 F.

This is the B&W CO Boiler, currently serving the nation's refineries by economically converting waste CO gases into working Btu's. This *boiler is specifically engineered for this task.* Fuel economies afforded by this unit, assure rapid pay-off periods and years of additional cost-saving operation.

When *you* are ready to cut refinery costs with a carbon monoxide boiler, get the facts on the one boiler designed specifically for the job—the B&W *CO* Boiler. B&W CO Bulletin G-87 covers the subject in detail. Write for your copy today. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

CO-109

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

CORROSION meets its match in Alcoa aluminum conduit

Here's an electrical rigid conduit that you can install and forget.

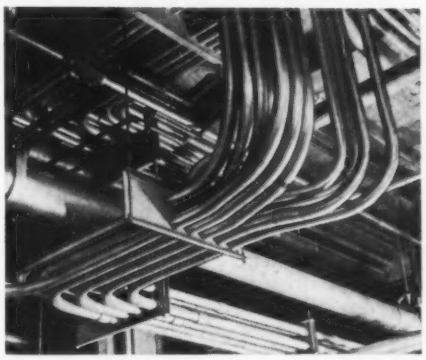
Alcoa aluminum conduit solves most corrosion problems in and around chemical plants.

Aluminum protects itself Unlike other conduits, which require some kind of coating, aluminum forms its own protective film. This film forms naturally in the atmosphere and in the presence of oxidizing agents. Damaged spots are self-repairing—almost instantly! The natural oxide coating on aluminum takes the place of factory coatings on conventional conduits and only under unusual conditions is any other protection required.

Other advantages Corrosion resistance is just one good reason for selecting aluminum conduit. Its light weight (about ⅓ as much as steel) makes it easier to handle and install. Alcoa aluminum conduit is also nonmagnetic and non-sparking.

How about cost? Consider initial cost, savings in installation and maintenance, and service life. You'll see that Alcoa aluminum electrical rigid conduit stacks up as a sound investment.

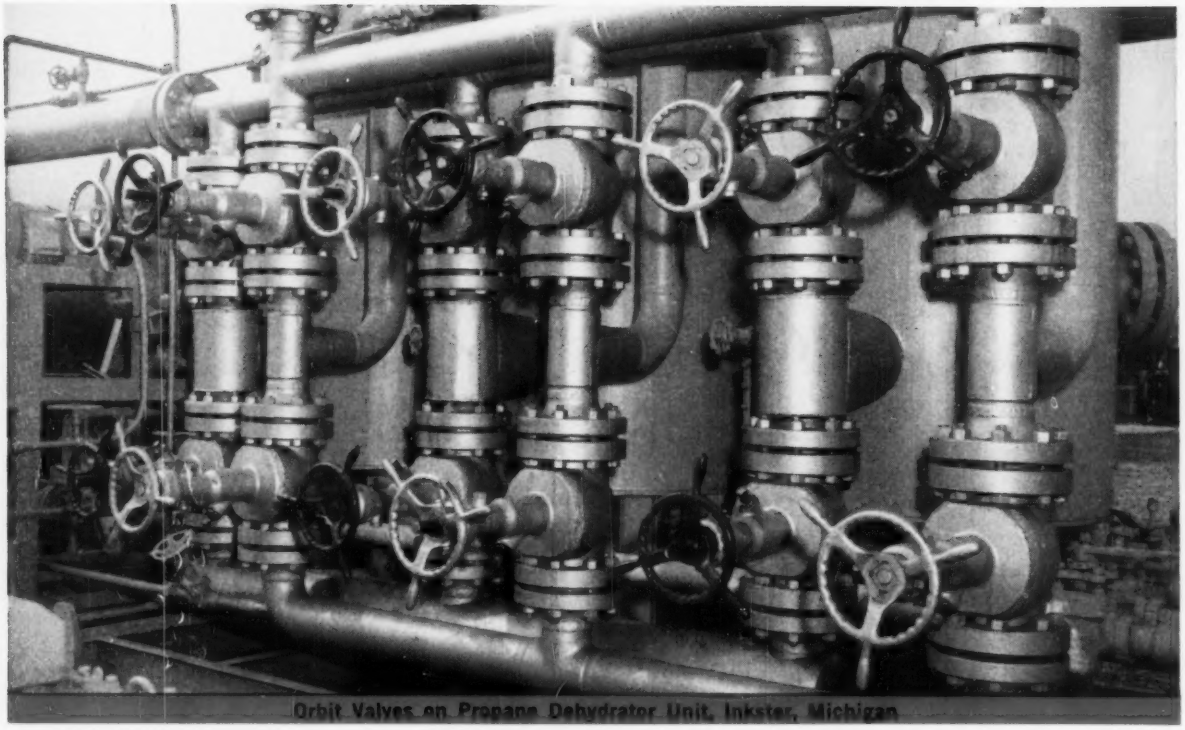
More information For specifications, or answers to specific questions about the use of aluminum conduit in corrosive environments, contact one of our nearby representatives. Or write to Rome Cable Division of Alcoa, Dept. 19-21, Rome, New York.



NO CORROSION despite moisture, chemicals and vapors in the basement of this sewage disposal plant in Cleveland. Installed in 1932, this Alcoa conduit still looks almost like new.

ROME CABLE
DIVISION OF **ALCOA**

NATIONAL ELECTRICAL WEEK
FEB. 5-11, 1961



Orbit Valves on Propane Dehydrator Unit, Inkster, Michigan

ORBIT VALVES ARE IMPORTANT PART OF EFFICIENT DEHYDRATION UNIT

HYDROCARBONS, AMMONIA, CARBON DIOXIDE, ETHYLENE, HELIUM, HYDROGEN, NITROGEN, NATURAL GAS — ALL REQUIRE DRYING UNDER CERTAIN CONDITIONS. ORBIT FORGED STEEL ASA CLASS VALVES MEET THE TOUGH CONDITIONS FOR DEHYDRATOR SERVICE.

The efficient operation of a dehydration unit is dependent upon the proper selection of all components. Here valves are required to provide absolute shut-off under such conditions as cyclic operation, high differential pressures, and wide temperature ranges. In addition, valves must be free from stem leaks, be free from sticking or freezing, and be free from dust build-up on seating surfaces.

Selected to handle this tough job — Orbit Full Opening Forged Steel Valves. These valves provide full flow, friction-free resilient seating and there is no chance for line build-up or trapping of solids or line fluids because there are no body cavities. Particles of drying agent cannot get between seating surfaces because valve is self-cleaning and dust carryover is swept through valve by gas streams.

The maximum rated working temperature for Orbit's standard line of ASA class valves has been increased from 250° Fahr. to 400° Fahr. Prices for these valves remain the same.

IN ADDITION Orbit ASA class valves are now available for 450° Fahr. Maximum rated working temperatures in 150-300-400-600 lb. Class. Write us for prices.

Learn how Orbit Valves can help your installation by writing to our Industrial Sales Department.

ORBIT VALVE COMPANY

P. O. BOX 699

TULSA, OKLAHOMA

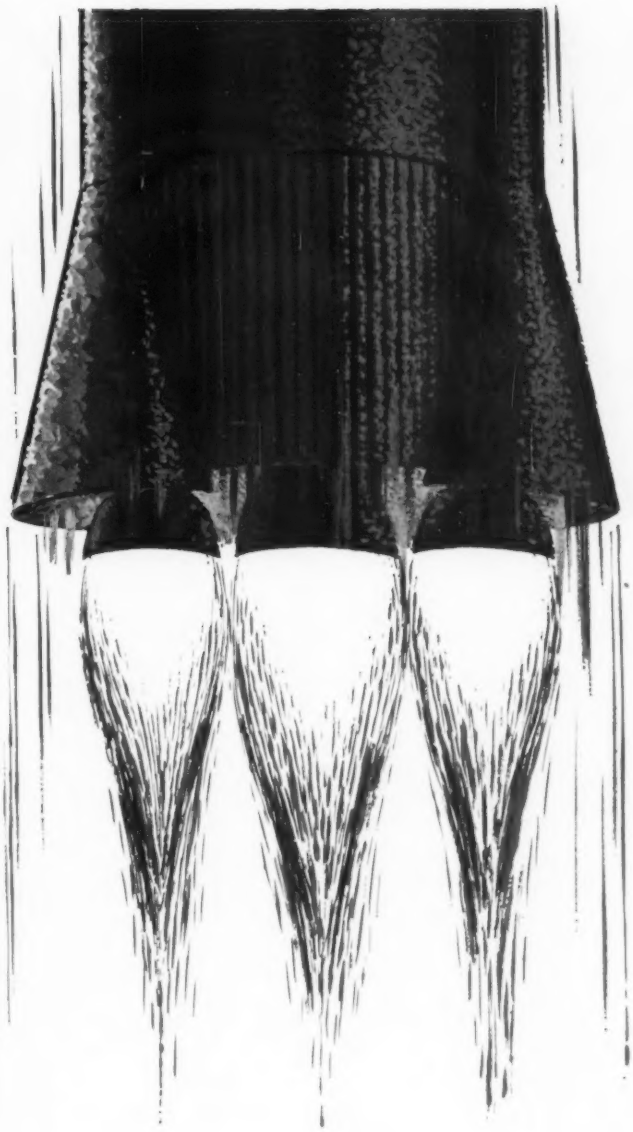
PHONE LUther 4-4761

TWX TU 925

Orbit ASA Class Valves are available through your favorite Supply Store

ORBIT VALVES ®

For more data on advertised products, use Readers' Service Cards, last page.



The race for space

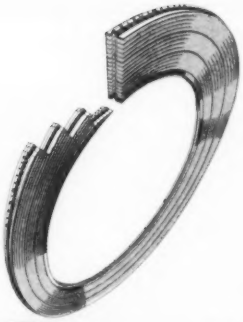
...where gaskets must not fail

The sealing of rocket fuel is an important contribution of Flexitallic Gaskets in man's conquest of space.

For this critical sealing application, it takes the Flexitallic Spiral-Wound Gasket construction — using the proper metal, the proper filler, and the proper yield characteristics determined by Flexitallic engineers.

Every Flexitallic Gasket is designed for the specific job it has to do—the sealing of corrosive fluids, temperatures from extreme sub-zero to maximum temperatures compatible with available metals. Pressures ranging to 15,000 lbs. p.s.i., or temperatures to 2500°F. do not impose impossible limitations. The Flexitallic Gasket construction compensates for unusual joint stress embodied in problems of thermal and physical shock.

Give us the facts about your most serious sealing requirements — in chemical processing, petroleum, power, marine, aircraft and missiles, diesel, or any other field. There's a Flexitallic Gasket to meet your needs — or Flexitallic will design one. Write Flexitallic Gasket Company, Camden 2, New Jersey. Stocking distributors for Standard Flexitallic Gaskets in principal cities.



Flexitallic®

SPIRAL-WOUND GASKETS

For more data on advertised products, use Readers' Service Cards, last page.

Make shorter work of TURNAROUNDS

Every OAKITE ECP utilizes chemical cleaning for towers

Where carbon and iron oxides and sulphides must be removed: circulate Oakite 85. Combining acid and solvent cleaning properties Oakite 85 penetrates heavy scales and corrosion-type soils, tears them from equipment walls, then rinses freely and completely. It's safer than raw acids, because it's inhibited against attack on ferrous metals . . . easy on synthetic rubber. One user says:

When this 40-ft., 12-tray tower was off-stream previously, "hand" cleaning required 5 days and $3,000. Using Oakite 85 by circulation method, we did a complete job of removing fouling soils in just 32 hours . . . for only $750.

For heavy oil, grease-laden soils and light rusts: circulate Oakite 77. Heavy-duty alkaline cleaning properties make Oakite 77 superior for penetrating, dissolving and dispersing heavy-oil and carbonaceous soils. It picks up light rust, too . . . leaves towers and tubes in top operating condition.

In cases where extra boosting power is called for to remove abnormally stubborn soils—add Oakite Acalaid to your cleaning solution. This brand new additive permits deeper penetration of soils . . . intensifies the purging action of your acid or alkaline cleaning agent . . . gives you a speedy, economical answer to your toughest tower-cleaning problem.

For more data on advertised products, use Readers' Service Cards, last page.

with an Oakite ECP

engineered cleaning program

A 90-foot tower cleaned in 15 hours . . . crude tower and heat exchanger purged to 99% cleanliness in 21 hours . . . partly plugged bundles saved from the scrap pile in just a few hours . . . 3½ *days* cut from previous record for cleaning an absorber . . . 5 days slashed from catalytic reformer turnaround time. These are *some* of the results of Oakite technical service.

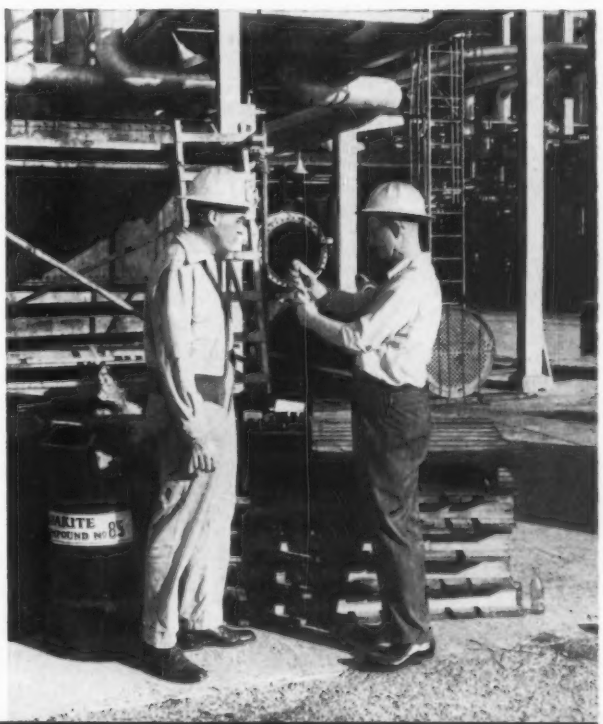
In each case, the procedure was initiated through the tower and tube bundle recommendations of an Oakite ECP. Did they save time, save cost, save trouble? You bet!

WHAT IS OAKITE ECP?

It's an Engineered Cleaning Program that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by materials known to make short work of refinery soils, by proved *methods.*

Ask the Oakite Engineer to recommend the best procedure for your next turnaround and follow up with an ECP for your refinery. Or, send for Bulletin F-10102 on tower and heat exchanger cleaning. Write Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.



OAKITE

over 50 years' leadership in industrial cleaning

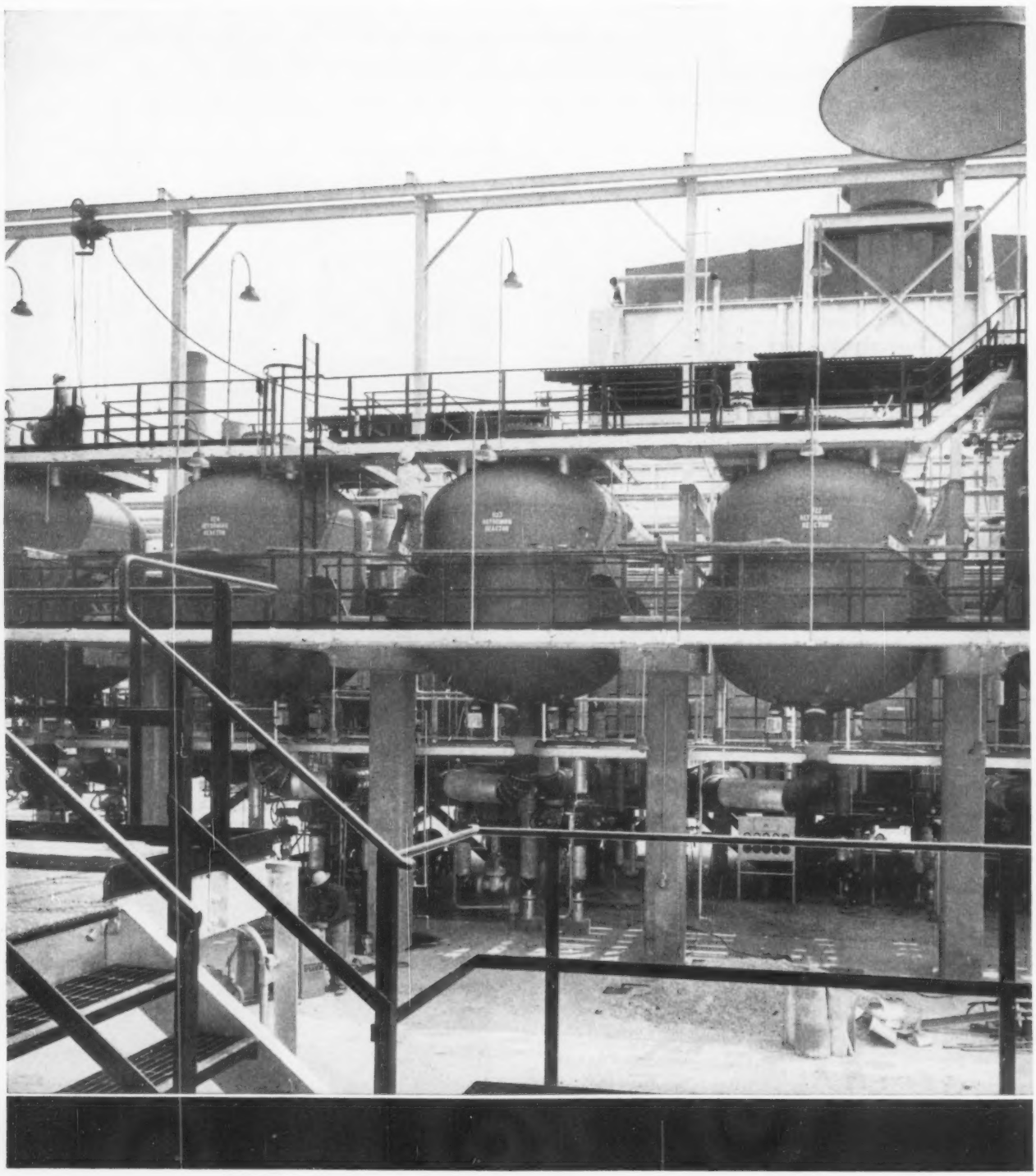
Est. 1909 SCIENCE

Oakite ECP

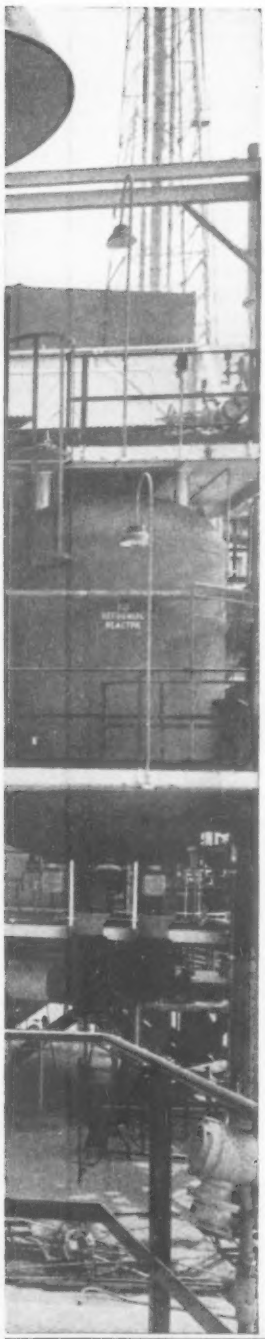
your economy key

For more data on advertised products, use Readers' Service Cards, last page.

Kellogg Know-How Optimizes



Investment in Cat Reforming



WORLD-WIDE RANGE OF INSTALLATIONS SHOWS FLEXIBILITY OF KELLOGG ENGINEERING-CONSTRUCTION SERVICES

To improve octane rating or to meet increased demands for petrochemicals, Kellogg is uniquely equipped to design or erect catalytic reformers to meet any specific need. Combined with Kellogg-designed hydrotreating facilities, cat reforming produces high octane gasoline of superior quality. The reformate is also a rich source of aromatics for petrochemical production.

Feedstocks reformed include light, heavy, and full-boiling virgin naphthas as well as thermally and catalytically cracked stocks which have been selectively pretreated. Products include aromatics such as benzene, toluene, and xylenes plus isobutane and hydrogen.

For further information on how Kellogg can optimize your investment in cat reforming, you are invited to send for an 8-page folder—"Regenerative Catalytic Reforming".

THE M. W. KELLOGG COMPANY

711 Third Avenue, New York

A subsidiary of Pullman Incorporated

Offices of other Kellogg companies are in Toronto, London, Paris, Rio de Janeiro, Caracas, Buenos Aires

KELLOGG

KELLOGG CAT REFORMING EXPERIENCE

Heath, Ohio	3,000 BPD
Houston, Texas	24,000 BPD
Bakersfield, California	4,000 BPD
Grand Prairie, Alberta	875 BPD
Antwerp, Belgium	2,500 BPD
Toledo, Ohio	12,000 BPD
Ponca City, Oklahoma	11,000 BPD
Lemont, Illinois	12,000 BPD
Vancouver, B.C.	4,000 BPD
Denver, Colorado	3,800 BPD
Montevideo, Uruguay	3,000 BPD
Concon, Chile	6,000 BPD
Kent, England	10,000 BPD
Dunkerque, France	10,000 BPD
Kwinana, Australia	10,000 BPD
Antwerp, Belgium	10,000 BPD
El Palito, Venezuela	6,500 BPD
Fremantle, W. Australia	6,000 BPD
Amarillo, Texas	5,000 BPD
Dinslaken, Germany	12,500 BPD
Izmit, Turkey	2,500 BPD*
Karachi, Pakistan	2,250 BPD*
Texas City, Texas	22,300 BPD
Wood River, Illinois	9,000 BPD
Baytown, Texas	20,000 BPD
Pointe aux Trembles, Quebec	4,500 BPD
Texas City, Texas	7,500 BPD
Ponca City, Oklahoma	3,850 BPD
Baytown, Texas	16,500 BPD
Oleum, California	8,000 BPD
Lockport, Illinois	7,500 BPD
Whiting, Indiana	9,250 BPD
Toledo, Ohio	5,500 BPD
Buenos Aires, Argentina	740 BPD
Destrehan, Louisiana	2,000 BPD
East Chicago, Indiana	12,780 BPD
Lake Charles, Louisiana	17,250 BPD
Whiting, Indiana	30,000 BPD
West Tulsa, Oklahoma	7,500 BPD
Regina, Saskatchewan	3,000 BPD
TOTAL	348,095 BPD

*Future

For more data on advertised products, use Readers' Service Cards, last page.

take NEWTHERM on test!

Test its STRENGTH

NEWTHERM is unusually strong and rigid—a feature of special importance in the larger, more vulnerable sections. Put a sample section or slab on part of your plant and *prove for yourself* its outstanding ability to withstand impact and water damage. See how it withstands rough handling in transit and erection, minimising breakage in shipment and erection by unskilled labour at the most remote sites.

Test its MOISTURE RESISTANCE

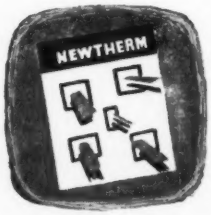
Even totally immersed in water, NEWTHERM retains much of its strength and rigidity. It does not become deformed when in contact with water, thus work-in-progress need not be covered. Especially on contracts where weather conditions would delay the application of insulation – NEWTHERM is the material to use.

Test its LIGHTNESS

Unusually light for such a high-efficiency material, NEWTHERM compares favourably in this respect with other insulants far inferior in strength. That means easier handling and fewer breakages—even the largest section is easily carried in one hand.

Test its EASE OF APPLICATION

Undoubtedly, NEWTHERM is one of the easiest of materials to apply. It is supplied in plastic form and in a wide range of standard-sized sections and slabs, smoothly finished and straight edged for immediate fitting. The finished job is very neat, with minimum joints, and appliers particularly appreciate the handleability of the material – especially in difficult situations.



READ ALL ABOUT NEWTHERM

in a specially prepared booklet. Sizes, compressive strength, thermal conductivity,—this and much more useful information can be on file if you write for your copy now, to the sole manufacturers Newalls Insulation Co. Ltd.

NEWALLS (Reg'd Brand)

***NEWTHERM** calcium silicate insulation*

. . . for temperatures up to 1400°F.

NEWALLS INSULATION CO. LTD.

Head Office: WASHINGTON, CO. DURHAM, ENGLAND.

A member of the TURNER & NEWALL ORGANISATION

Offices & Depots at: LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, DUBLIN, BRISTOL & CARDIFF.

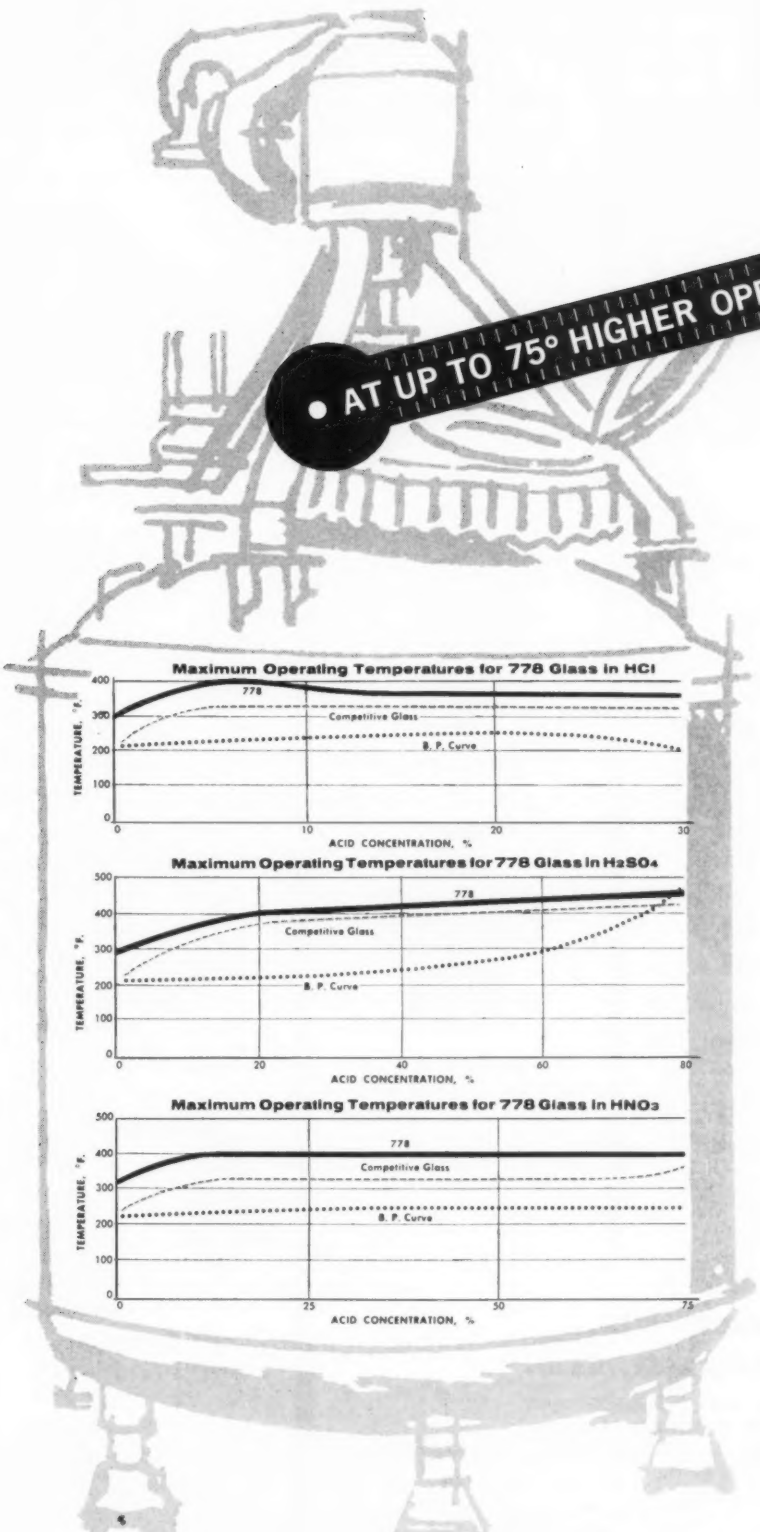
Agents and Vendors in most markets abroad.

59

MORE ACID RESISTANT

AT UP TO 75° HIGHER OPERATING TEMPERATURES

and now standard on all GLASCOTE process equipment



Take a good look into the Glascote reactor shown at the left — it contains proof that you can speed reaction time in vessels lined with sensational Glascote 778 . . . that you get a glass lining that extends acid resistance to 75° F higher operating temperature. And all this with no sacrifice in its ability to resist alkalies and thermal shock.

No wonder so many of our customers specified Glascote 778 . . . small wonder that we have this remarkable acid-resistant glass standard on all Glascote reactors, columns, storage tanks, rotary dryer-blenders, pipe and fittings. But keep in mind that this popular glass lining is just one of over 3000 formulations. Some may be even more effective for special requirements.

For your convenience we have prepared a special "resistance rule." It lists 150 chemicals and shows at a glance the ability of Glascote 778 to resist their corrosive attacks. Send for your rule today or see your Glascote representative.

Through research . . . *a better way*

A.O.Smith
CORPORATION

Subsidiary: GLASCOTE PRODUCTS, INC.
Cleveland 17, Ohio

World's largest manufacturer of glass-protected steel products

For more data on advertised products, use Readers' Service Cards, last page.

specify

MUELLER®

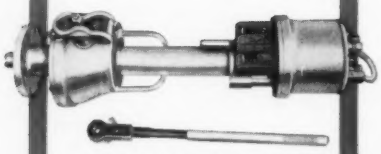
proven *products for water systems*

Assure long, trouble-free operation with a minimum of maintenance by installing dependable Mueller products in all of your water systems.

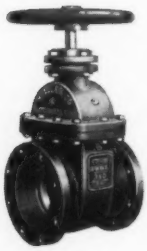
For more than a century, Mueller Co. has been a leading manufacturer of quality products for the water works industry. Many of these products have been adopted as standards of the water works industry.

Today, Mueller Co. offers a full line of *proven* products for use in any type of water system. Just a few of these items are shown. Write for complete information. Ask about Mueller products for fire protection systems, too.

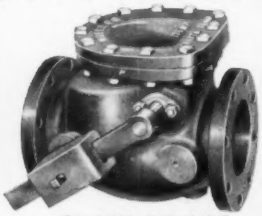
Mueller Co. also makes a complete line of No-Blo® Products and Equipment for the petroleum and gas distribution industries.



DRILLING MACHINES

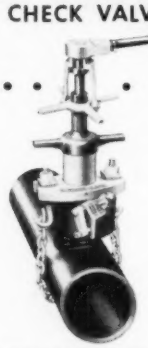


GATE VALVES

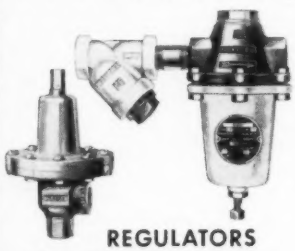


CHECK VALVES

TAPPING SLEEVES AND VALVES



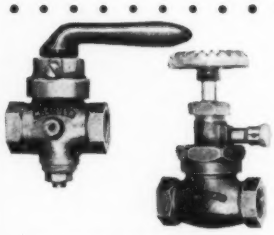
TAPPING MACHINES



REGULATORS AND RELIEF VALVES

BRASS STOPS

SERVICE CLAMPS



PLUMBING VALVES

MUELLER CO. since 1857 SERVING the Water and Gas Industries QUALITY

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles
In Canada: Mueller, Limited, Sarnia, Ontario

5586

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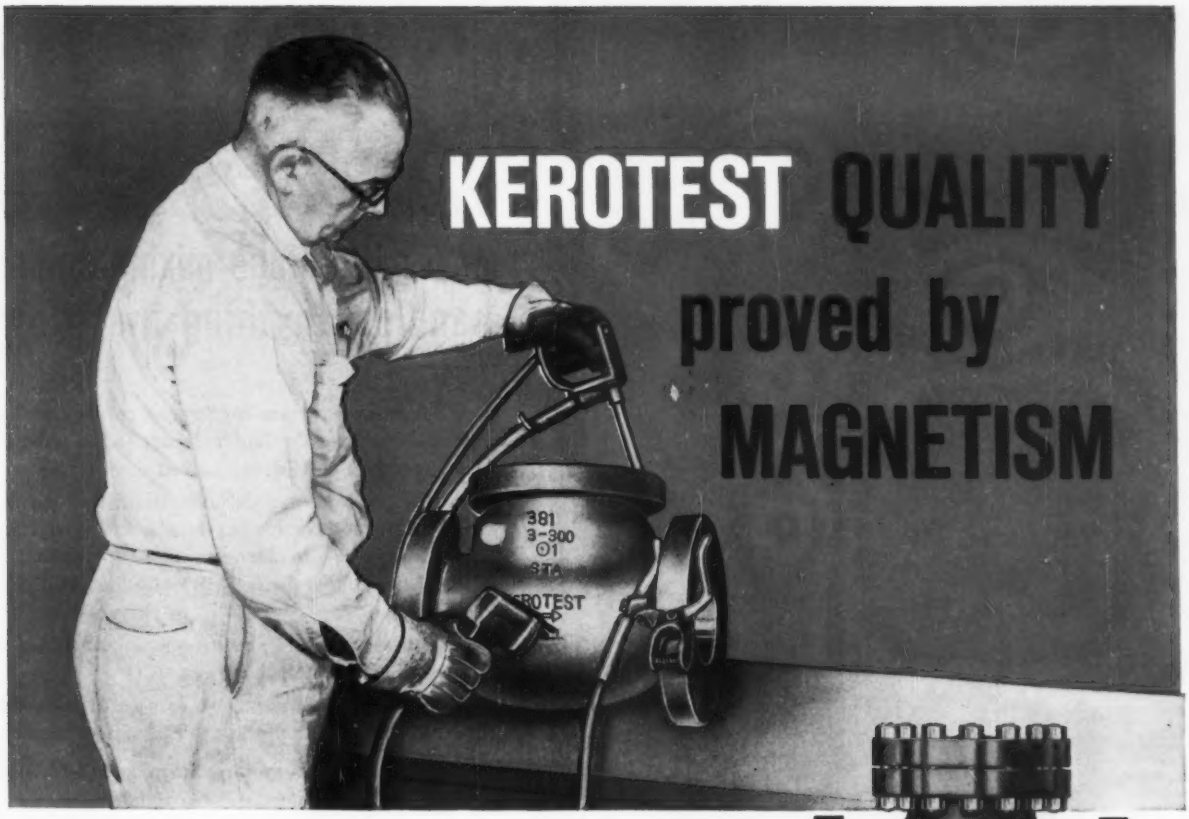

This veteran Kerotest inspector is setting up a flaw-finding magnetic field between the two electrodes. He'll cover every inch of the casting – electronically seeking out minute and hidden cracks, sand holes and other potential failure points. This swing check valve body must receive his unqualified stamp of approval before it is accepted.

Magnetic particle inspection is one of more than half dozen laboratory and manufacturing quality control procedures at Kerotest. Kerotest standards of quality insure *consistent* production of trouble-free valves. A Kerotest valve in the line is your best insurance against costly down time . . . your best protection against failure in critical and hazardous applications.

Kerotest Cast Steel Swing Check Valves

High quality Kerotest cast steel swing check valves are available in primary service pressure ratings ranging from Series 150 to Series 1500. They are supplied in all regularly used sizes for all types of service in oil, gas, steam, water, chemical, petro-chemical, marine and industrial installations.

Send for your free copy of the new, informative Kerotest booklet. It's packed with working tables, dimensions, specifications and other helpful information.

KEROTEST
Quality Controlled Features

- Durable wall sections for maximum safety
- Designed to permit passage of line scraper equal to inside diameter of pipe
- Threaded bottom seating type rings made to allow full flow, obstruction-free passage
- Rigidly supported disc allows self-alignment
- Counterbalanced discs available for minimum pressure applications

There is a Kerotest Cast Steel Valve available for every class and condition of service

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In Canada . . . Kerotest Cast Steel Valves are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario, Canada

KEROTEST ®

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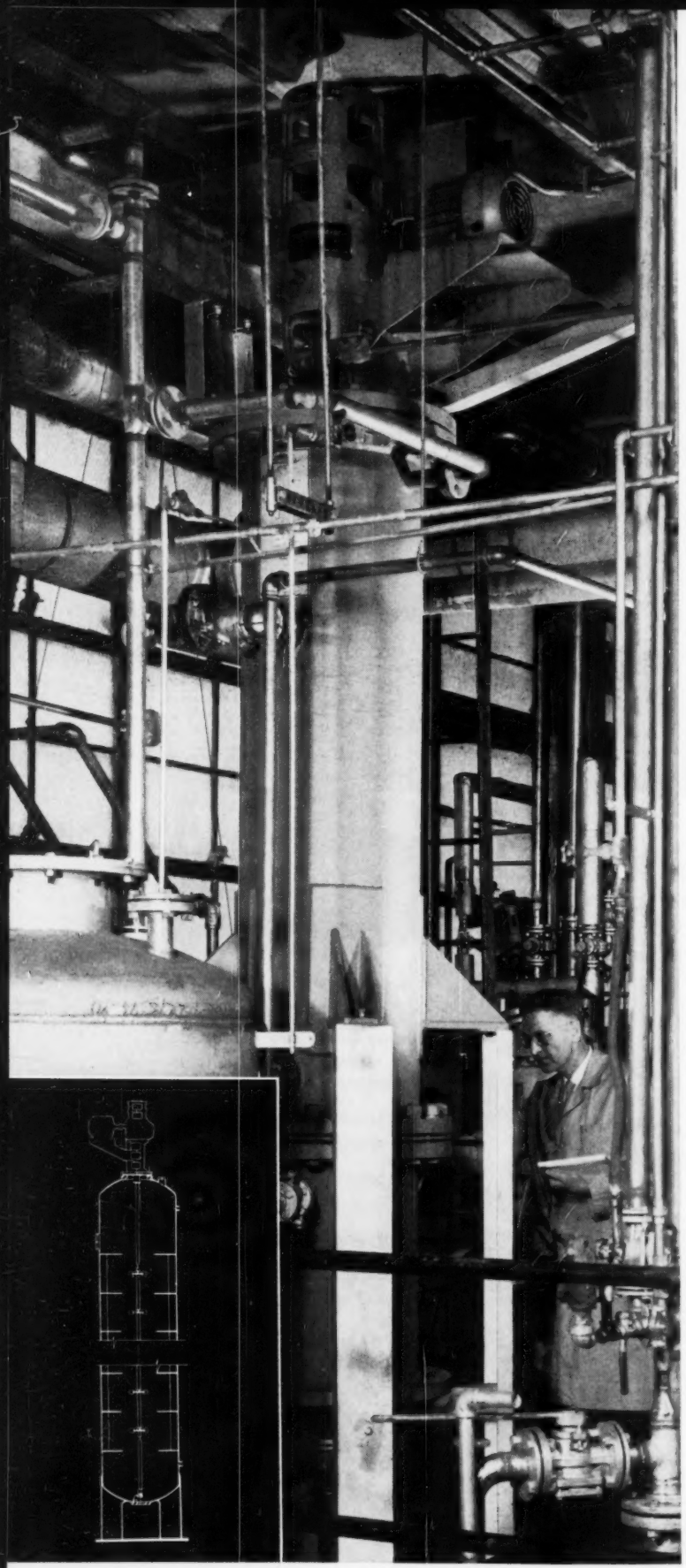

CMCONTACTOR can be pilot plant size or as large and as high as needed. Corrosion-resistant materials are readily supplied. Here a CMContactor reclaims a chemical from process liquor at photo chemicals division of Eastman Kodak Company.

LIGHTNIN CMCONTACTOR®

new multi-stage mixing column handles anything that flows

Don't freeze your plans for "going continuous" on a process until you've had a chance to see what the new LIGHTNIN CMContactor can do for you.

In one package it combines mixer and process vessel, designed to fit your needs, in materials of your choice. It can accommodate *any* fluids, including gas dispersions, heavy slurries, and thick viscous liquids.

It handles any type of continuous operation. And it gives you predictable results.

Here's why you'll find you can get results with the CMContactor that you can't get any other way:

1. **No fouling or plugging.** Simple, self-cleaning design makes it possible to handle fluids of high solids content. Solids can be carried through with the flow stream, settled against the liquid flow current, or retained in the column.
2. **No guessing when you scale up.** Fully baffled system means a controlled flow pattern within each stage, free from problems of channeling, wall effects, packing wettability, and head differentials. Pilot plant conditions can be duplicated with precision in columns of any size.
3. **Selected mixer speed for each flow rate.** As flow rate changes, mixer speed can be adjusted to give optimum performance for that specific throughput.

We help you pilot-plant the process. We'll test-run it for you in our own laboratory. Or you can rent or buy a pilot CMContactor and we'll help you with your own test runs.

To get a fuller idea of the efficiency this versatile new process tool can bring to your operations, call in your LIGHTNIN Mixer representative now. You'll find him listed in Refinery Catalog and in the yellow pages of your telephone book. Or write us direct.

Lightnin® Mixers

MIXCO fluid mixing specialists

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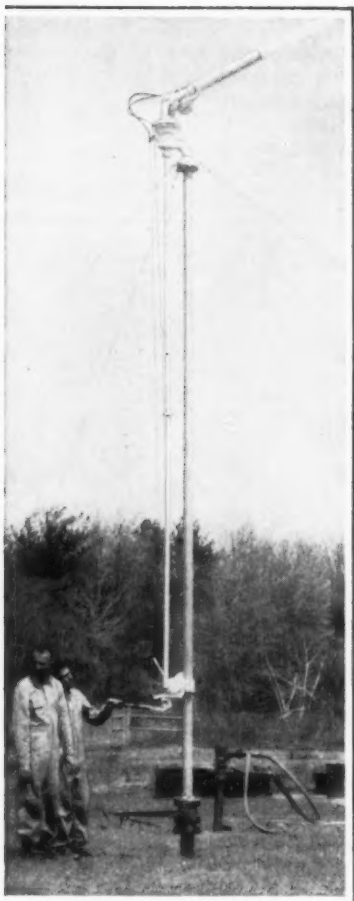
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

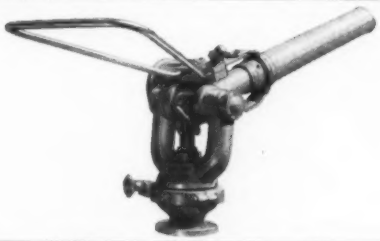
In Europe: Lightnin Mixers, Ltd., Poynton, Cheshire, England.

Most Complete Line of Specialty Turrets on the Market!

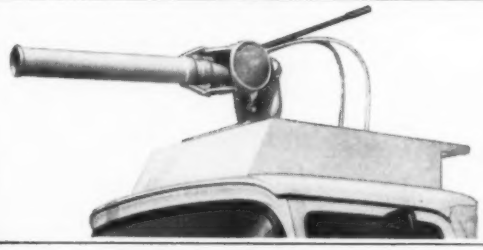
...All Rockwood Turrets Discharge FogFOAM
Solid FOAM Stream — WaterFOG — Solid Water Stream



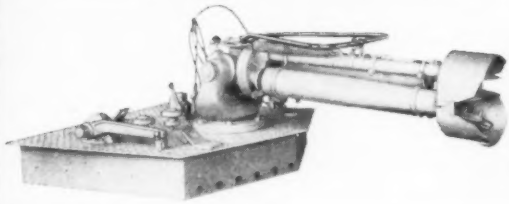
Extended Manual Control Type — Turret nozzles extend 10 to 20 feet above remote control station on deck or ground on standard units . . . greater remote extensions for special applications.



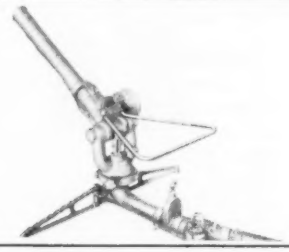
Direct Manual Control Type — Gives fire fighters "out-in-the-open" control from cab roof!



Remote Manual Control Type — Easily handled by man in driver's seat. Ideal for fast action!



Remote Hydraulic Control Type — Power-controlled from within the cab. Single and dual models. Widely used on air crash rescue fire-fighting trucks.



Portable Type — Off the truck and into action in seconds! Goes wherever a fire fighter can bring the proper hose line into action!

On the truck or on the ground, fire fighters can hit fires *harder* using ROCKWOOD Turrets! At airports and refineries . . . in municipalities and throughout industry . . . these advanced-design fire-fighting aids are constantly proving their ability to extinguish fires faster.

ROCKWOOD Turrets provide plenty of volume *and* versatility. What's more, all are easily adjustable on the fire line to meet changing fire conditions. Produced by the world's largest manufacturer of specialty Fire-Fighting Turrets, they're designed to give fire fighters an extra edge of efficiency on most types of fires. Get full details on the complete line of fire-fighting products. Write ROCKWOOD SPRINKLER COMPANY, Portable Fire Protection Division, 508 Harlow Street, Worcester 5, Massachusetts.

ROCKWOOD SPRINKLER COMPANY
A Division of The Gamewell Company
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Engineers Water ... to Cut Fire Losses
Distributors in all principal cities.

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During recent months, Western has become increasingly aware of the great interest shown by the engineering profession towards personal self-improvement, and as a contribution has had several short booklets prepared, covering a wide range of subjects which have significance for the career engineer. They are now offered as a set, as a courtesy to anyone who desires them.

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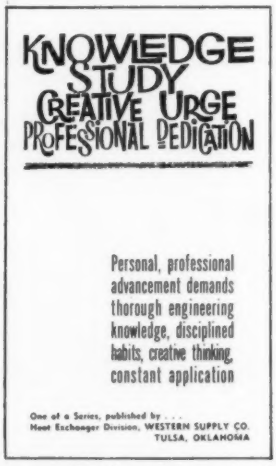
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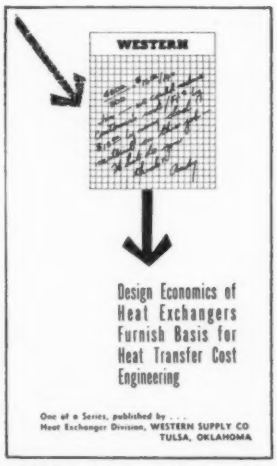
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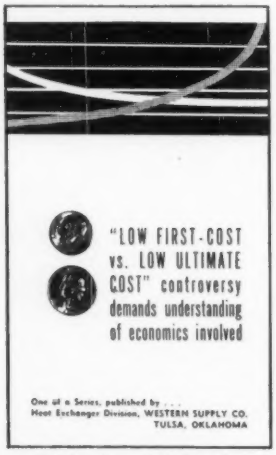
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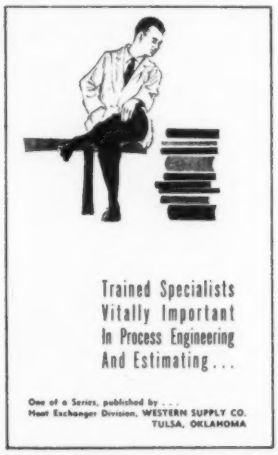
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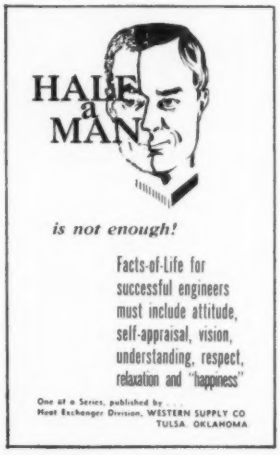
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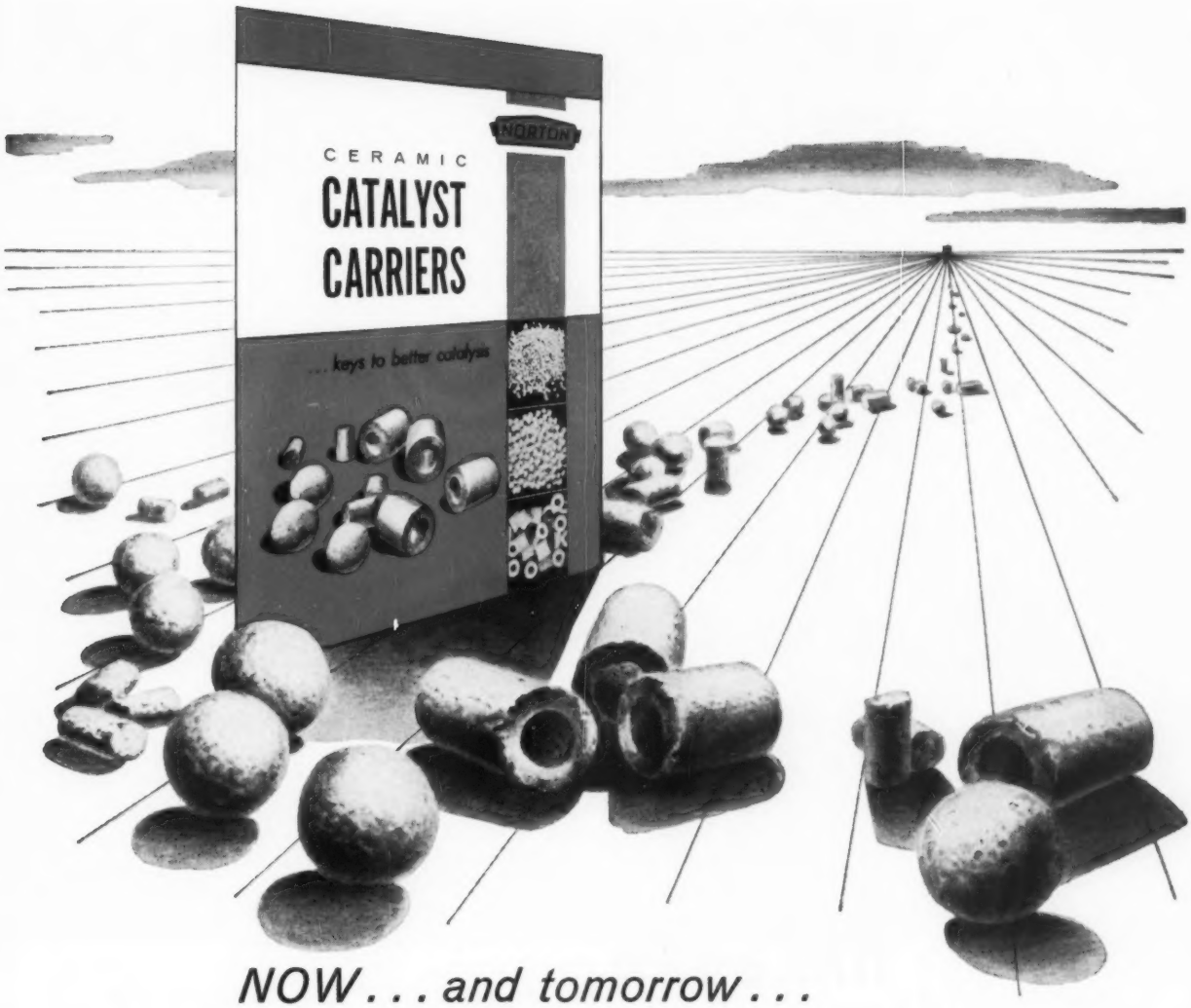

NOW . . . and tomorrow . . .
choose NORTON Ceramic Catalyst Carriers

In columns and reactors throughout the chemical and petrochemical industries, NORTON Ceramic Catalyst Carriers are helping processors to improve catalyst activity and life, lower catalyst costs, get optimum yields from reactions.

It's *consistent* high performance too, because *every* NORTON Carrier is uniform in *any* quantity from lot to lot. Size, weight, porosity, and purity are held to close tolerances. Duplication of specifications is assured.

Today, probably the most widely-used NORTON Carrier is alumina . . . in ring, sphere, and pellet form and as granules and powder. However, as new feedstocks are developed, and more demanding physical, chemical, and thermal conditions are encountered, new NORTON Carriers will be ready to meet catalysis specifications. For example, various materials are now available in experimental quantities as spheres, rings and pellets . . . in alumina, magnesia-alumina spinel, fused magnesium oxide, silica, zircon, zirconia and silicon carbide. These NORTON developments offer porosities ranging from 4% to 65%; surface areas from less than 1 to $70 m^2$/gram (BET method).

Also readily available is the technical assistance of the Norton Man. Through him, chemical engineers can draw upon the wealth of research and engineering data compiled over the years by the NORTON COMPANY. He is well qualified to help *you* meet catalyst carrier specifications exactly . . . efficiently . . . economically.

NORTON Carriers are described in detail in the Bulletin, "Keys to Better Catalysis". For your copy, or for technical assistance, write NORTON COMPANY, Refractories Division, 461 New Bond Street, Worcester 6, Massachusetts.

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NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

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HARSHAW

makes catalysts to your specifications

HARSHAW
has the facilities for producing carload quantities of
PREFORMED CATALYSTS
to fit special process requirements

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Aluminum Isopropoxide		Aluminum Nitrate
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Nickel Carbonate	Nickel Formate	Nickel Nitrate
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Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

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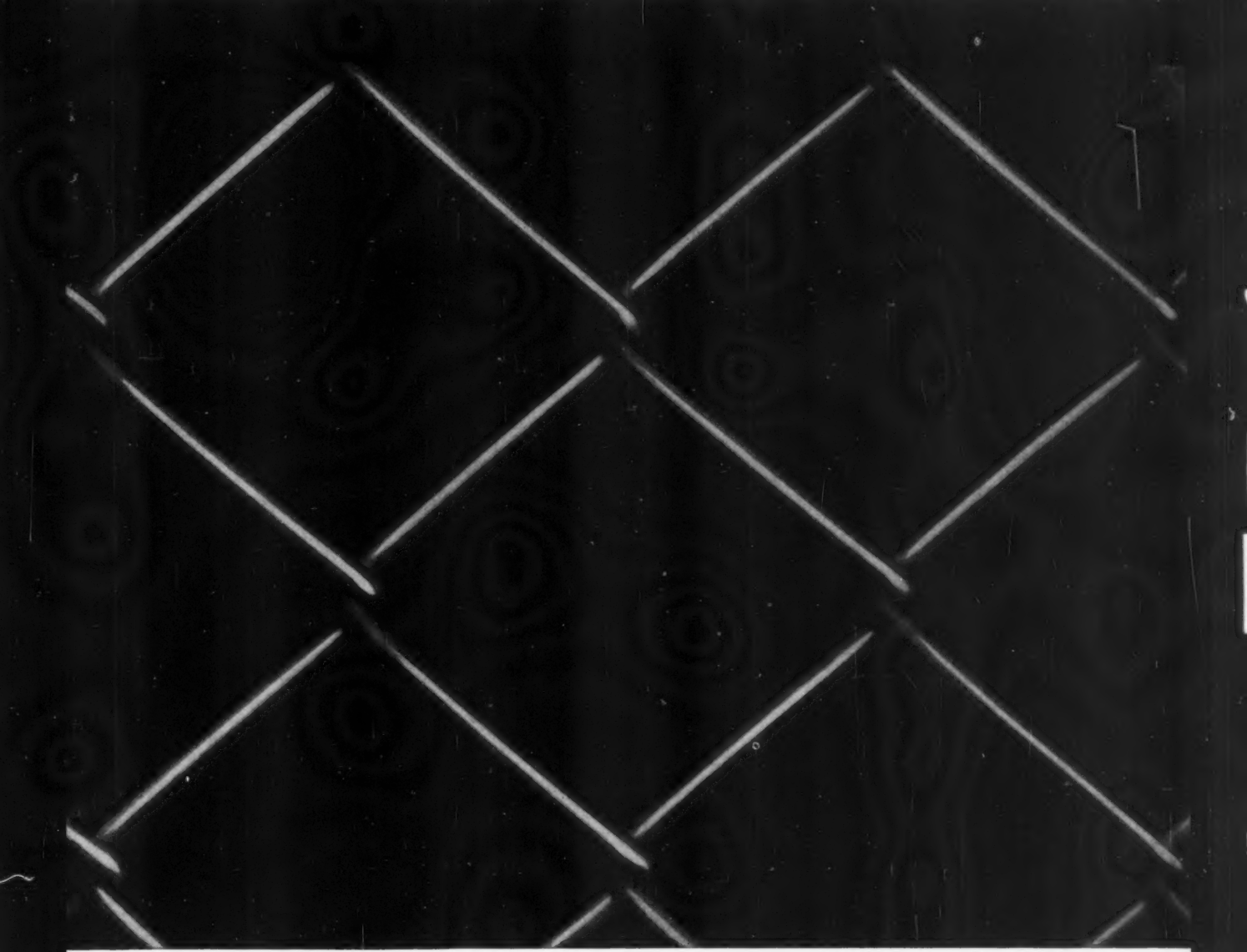

USS Cyclone Fence with new Amershield wire lasts up to three times as long

Now—Cyclone gives you steel *and* aluminum in one fence! USS Cyclone Amershield aluminum-coated wire combines the strength of steel with the weather resistance of aluminum. After eight years of rigorous testing, we know that this new wire lasts up to three times as long as galvanized fabric. Yet it costs little more, so you get a lot more fence for your money.

USS Cyclone Amershield wire is a high-quality product which will provide added years of maintenance-free service in severe industrial and marine atmospheres. It's *far* more corrosion-resistant than any other metallic coated fencing material. It withstands temperatures as high as 1650°F., and all with the strength of steel.

You'll want this new, better protection around your plant or property. Get all the particulars—features, physical properties, specifications—just by sending in the coupon. Our free descriptive literature will be sent to you immediately.

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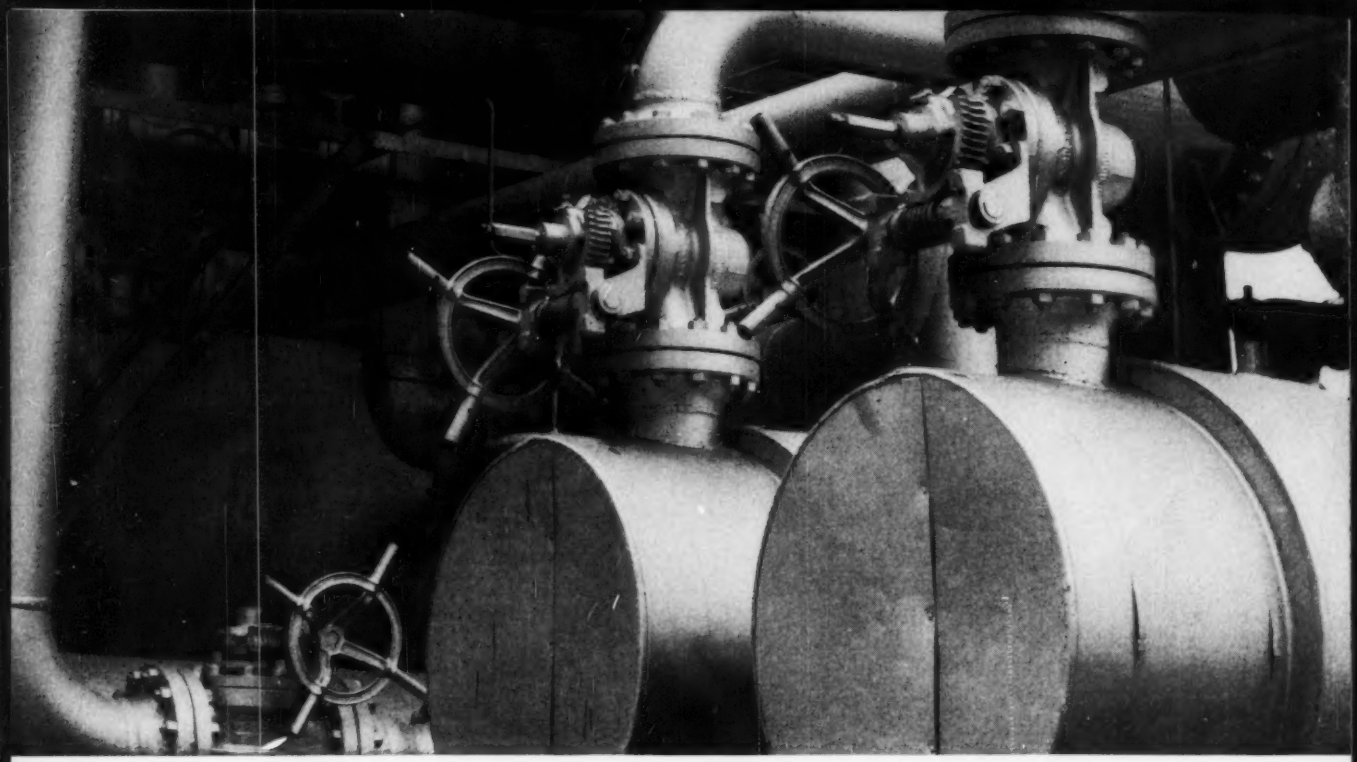

K-51 (Penton) coated Rockwell-Nordstrom valves resist attack by a wide range of corrosive refining fluids.

SPECIAL COATINGS CUT VALVE COSTS

Now, Rockwell-Nordstrom lubricated plug valves are available with special coatings to solve a wide number of corrosion problems that used to require costly special alloy valves.

K-51 (Penton) plastic coatings give iron or steel Rockwell-Nordstrom valves an exceptional corrosion resistance against attack by most acids, caustics and organic-inorganic solvents . . . Kanigen (metallic nickel) coatings assure the corrosion resistance of nickel or stainless steel . . . and Teflon coated plugs assist lubricant efficiency on services where inadequate or infrequent lubrication is anticipated. Whatever your valve needs, for the most difficult services or the easiest ones, the *complete* line of Rockwell-Nordstrom lubricated plug valves can fill your needs better and at lower cost. Write for complete details: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited. Rockwell International S.A., Geneva, Switzerland.

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another fine product by

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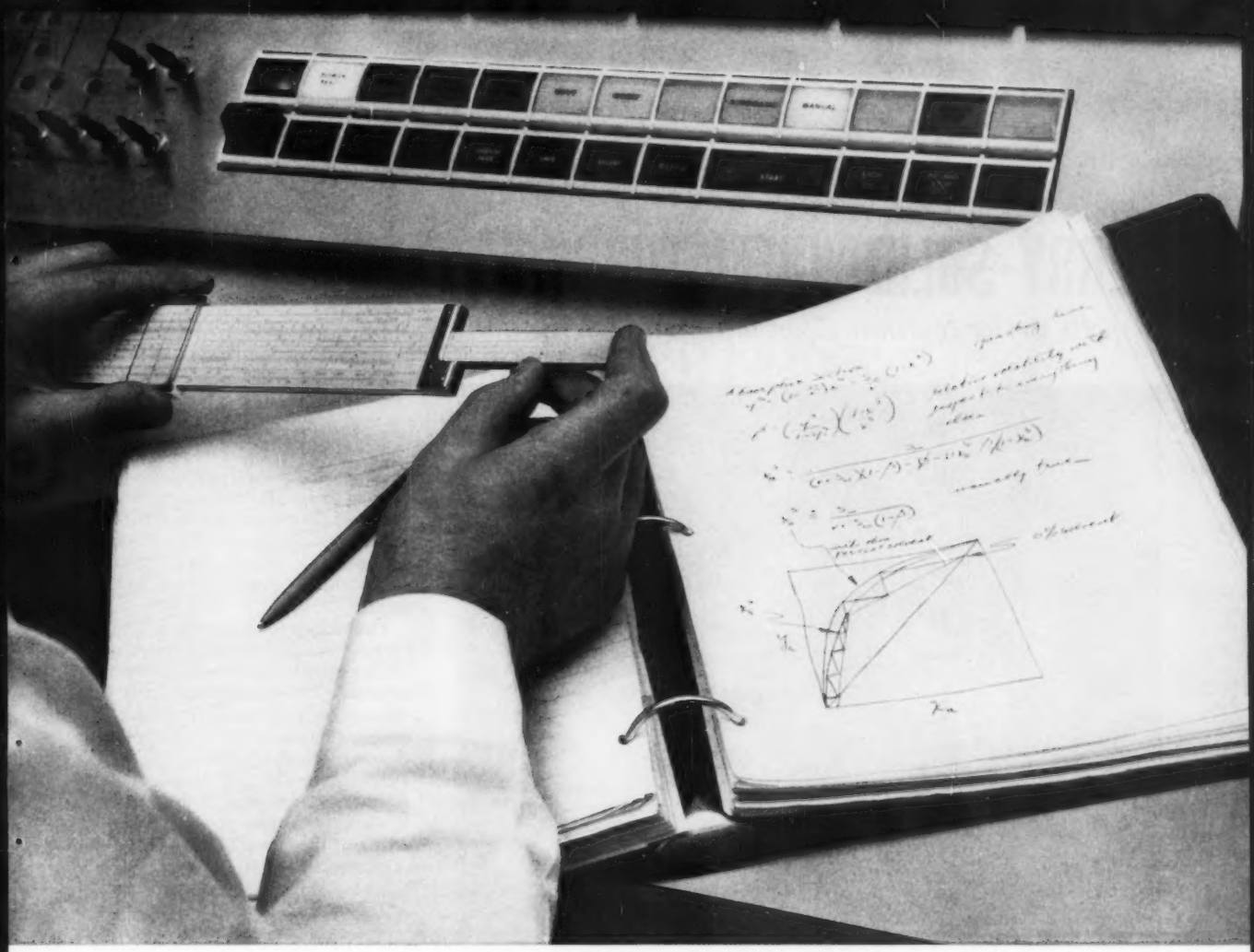
At tank farms, Rockwell-Nordstrom valves with Teflon coated plugs insure longer performance and instant operation at points remotely located from plant.



Solve vapor-liquid equilibrium problems quickly, easily with the new low-cost IBM 1620

You can now perform unit operations calculations in minutes with IBM's new Unit Operations Simulator for the 1620. The Simulator consists of 13 automatically available sub-routines*. These are short programs stored in the machine which can be called on to solve your vapor-liquid equilibrium problems.

Included also is an interpreter which allows you to link together the sub-routines you want to use for the problem you are working on at the moment. The *language* of the interpreter is symbolic. This makes it easy to use and eliminates the need to write a detailed program in machine language.

The Unit Operations Simulator is available free of charge to all users of IBM 1620 Data Processing Systems. A basic 1620 rents for just $1,600 a month. Ask your local IBM representative to give you complete details on this versatile, low-cost engineering computer.

IBM's 1620 is a compact desk-size computer.

***Here's what the Unit Operations Simulator does for you: 1.** Computation of equilibrium constant. **2.** Computation of temperature from a given equilibrium constant. **3.** Computation of enthalpy of a vapor and/or liquid stream. **4.** Find equilibrium constant nearest unit. **5.** Computation of temperature from a given enthalpy of a vapor and/or liquid stream. **6.** Bubble point and dew point calculations. **7.** Split one stream into two at specified ratio. **8.** Mix two streams of same phase. **9.** A mixed feed adiabatic flash calculation. **10.** Adiabatic flash. **11.** Isothermal flash. **12.** Flash to a specified quantity of vapor. **13.** Absorber/stripper calculation using Edmister short cut.

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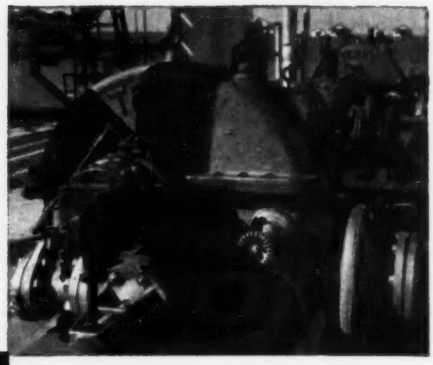
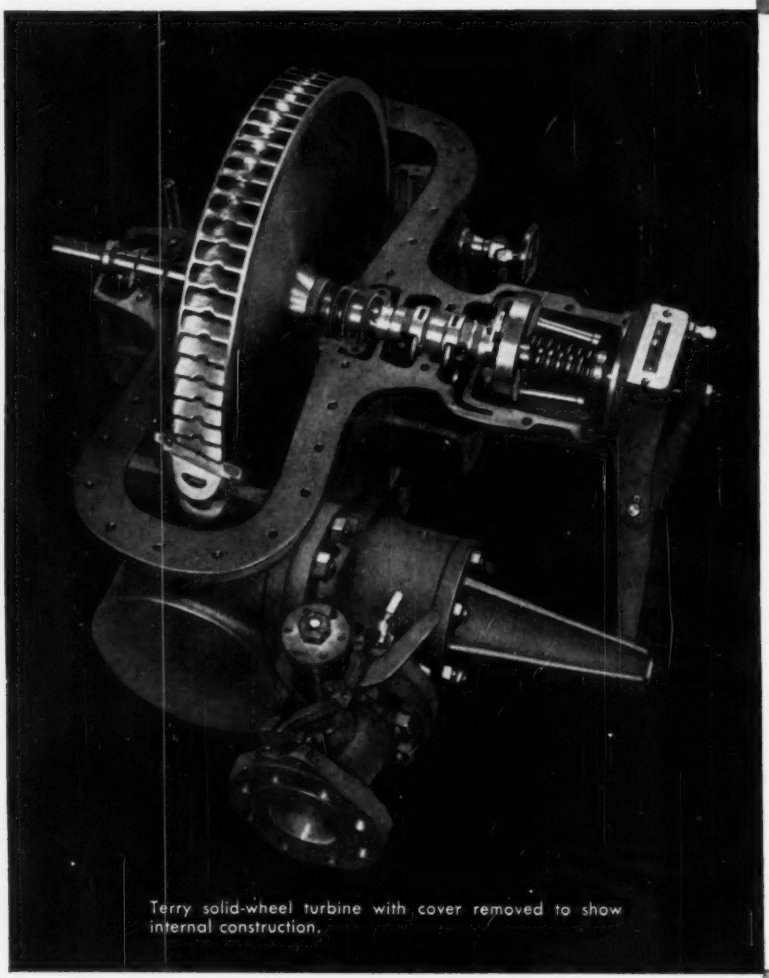
TERRY SOLID-WHEEL TURBINE

spells service continuity for mechanical drives





Terry solid-wheel turbine with cover removed to show internal construction.

For mechanical-drive applications, such as these, you will never find the equal of Terry solid-wheel turbines for built-in dependability. They are *designed* for trouble-free operation under the toughest service requirements.

The wheel, for example, is a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out. The blades can't foul since they are double-rim protected...with one-inch clearances at either side.

Any blade wear, which might occur after years of service, is of little consequence. As the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.

Specify Terry solid-wheel turbines for your next mechanical drives. They are available in capacities from 5 to 2,000 hp., speeds up to 10,000 rpm. Vertical turbines are built in sizes from 5 to 300 hp.

For full information about these reliable turbines, send for bulletin S-116.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

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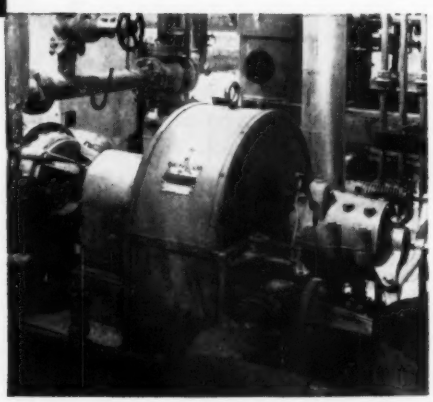

TT-1216

Valuable blending services available to Du Pont tetraethyl lead customers

When the familiar yellow and green Du Pont tank car rolls onto one of your blending plant sidings, you're taking delivery of more than a shipment of tetraethyl lead—for the services that go with it can be as valuable to you as the antiknock compound is to the quality of your gasolines.

For example, if you're planning continuous in-line blending of gasoline components, Du Pont men are ready to help you with their experience. If you're planning a more modern blending plant, our operations group will be glad to assist your engineers in developing and perfecting its design.

In addition, special services are available for blending plant construction and operation, including, for example, site selection and the training and medical examination of blending plant personnel.

But comprehensive blending plant service is just one example of the many services available to Du Pont tetraethyl lead customers. Your Du Pont Petroleum Chemicals representative will be pleased to discuss them with you. For more information, contact him or write to E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

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Better Things for Better Living
. . . through Chemistry

Lead Antiknock Compounds *and other* PETROLEUM ADDITIVES

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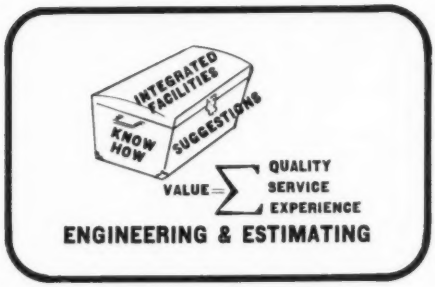
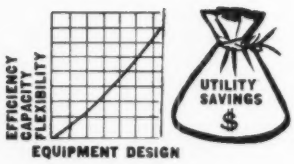
Your Engineering and Estimating Staff Also Evaluates The Past, Present, and Future Value and the Potential of Your Equipment Sources...

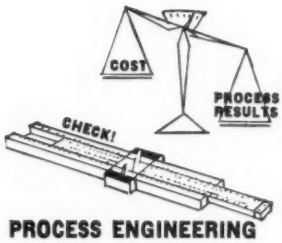


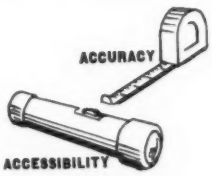
Glitsch Quality, Service, and Experience Date Back 48 Years

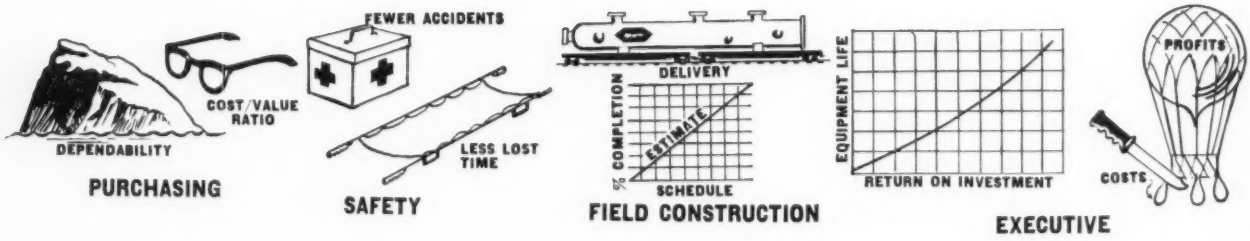


Glitsch experience and integrated facilities produce equipment of "plus-quality" at a cost/value ratio that is not only economical, but important for consideration by each member of your composite management and engineering staff.

Design and fabricating suggestions by Glitsch are yours for the asking!







PRODUCTS — Glitsch Lightweight "Truss-Type" Ballast Trays, Sieve, Bubble Cap, Dualflow, Disc, Donut, Accumulator, and Mist Eliminator Trays .. Pressure Vessels, Contactors, Reactors, Filters, Heat Exchangers, and Other Specialty Products... Bubble Cap and Riser Assemblies, Flanged and Dished Heads, Machine Time, Stampings Knitted Wire and Woven Wire Screen.

TECHNICAL — **Fractionating Tray Engineering:** Process, Mechanical, Structural, and Metallurgical Designing. **Pressure Vessel Engineering:** Pressure, Temperature, Wind, Earthquake, and Dynamic Designing. **Special Product Engineering:** Research and Development and Model Mock-Up. **Special Tooling and Machine Design** for Specific Purposes and Problems.

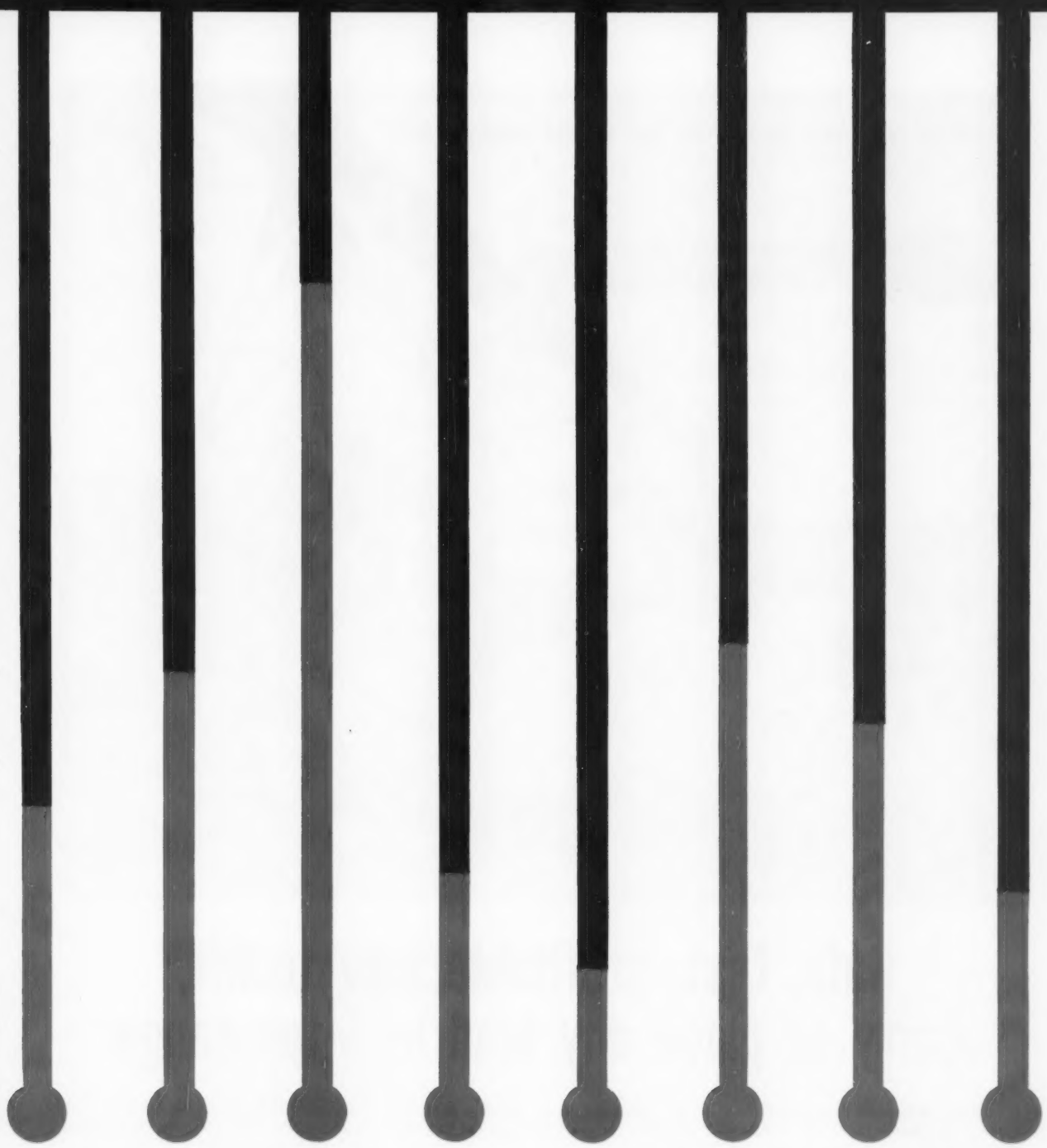
Glitsch
SINGLE ENGINEERING RESPONSIBILITY

FRITZ W. GLITSCH & SONS, INC.

General Offices and Manufacturing Plant: 4900 Singleton Boulevard, Dallas

Houston • Tulsa • Baton Rouge • Cleveland • New York City • Los Angeles • Charleston, W. Va. • Uxbridge, Canada • Monterrey, Mexico

For more data on advertised products, use Readers' Service Cards, last page.



Hagan reports on Temperature Control

Daniel Fahrenheit graduated the measurement of hotness in 1714. Since that time the automatic control of temperature has been particularly challenging, involving the control of variables and time-delays, as well as the full range of controller actions (gain, rate, reset, bias).

Hagan temperature controllers have been successfully applied where product quality or quantity is a direct reflection of the precision regulation of temperature. Corrosion-resistant Hagan temperature measuring devices have been designed to meet Division One area requirements; are extremely easy to maintain and trouble-shoot.

By the use of suppressed range measuring devices, Hagan can hold temperature as high as 3000°F to within one degree or less, and follow set points with a repeatability of 0.1% full range. As an example of really precise control, Hagan Powr-Mag is controlling glass fiber drawing dies operating at 2200°F. Despite wide variations in glass melt temperature, die temperature fluctuation is limited to less than 0.25°F.

Measuring and regulating all the variables that enter into process control is a part of Hagan's forty years of experience in the design and manufacture of instrumentation and control elements. For information on the complete Hagan line of electronic, pneumatic and hydraulic controls, write or phone HAGAN CHEMICALS & CONTROLS, INC., Hagan Center, Pittsburgh 30, Pennsylvania. Telephone WAlnut 2-3737.

HAGAN

Safe, fast, profitable way to lift, carry or place any load in 5-ton range

It's Austin-Western's economical new 3-wheel hydraulic crane! This versatile Model 110 is your answer to the limitations of fork lifts and conventional 3-wheel cranes. Why? Because of its 18-ft. 7-in. telescoping boom and 220° swing. The 110 can actually outlift all other 3-wheel cranes over-the-side. Its low 8-ft. 10-in. overhead clearance and the easy maneuverability of its dual tire, rear trunnion power steering permit it to work in even the tightest quarters with ease.

Other time and money saving features include dual front driving wheels; road speeds from 2 to 18 mph. Torque converter and full hydraulic reversing mechanism are standard. The 110 can be adapted to your particular job needs with various combinations of features and equipment. And it's designed and built for easy, economical, troublefree maintenance.

Why not take a good look at this versatile new piece of materials handling equipment. Ask your Austin-Western distributor for a demonstration or write us for details.

A-W hydraulic cranes are available in 5 models; capacity ranges from 5 to 11 tons!

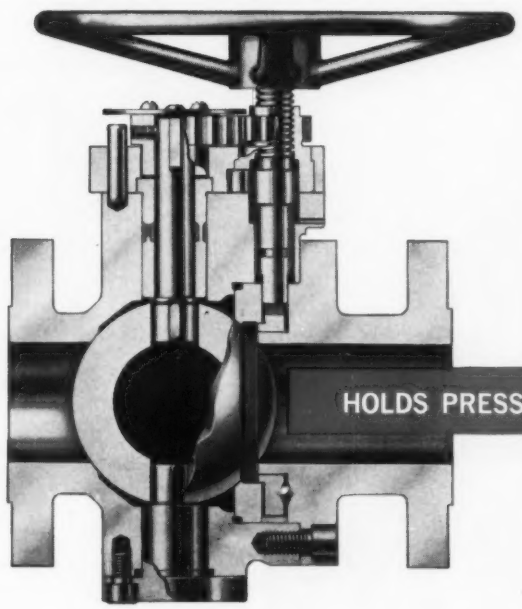
Austin-Western CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

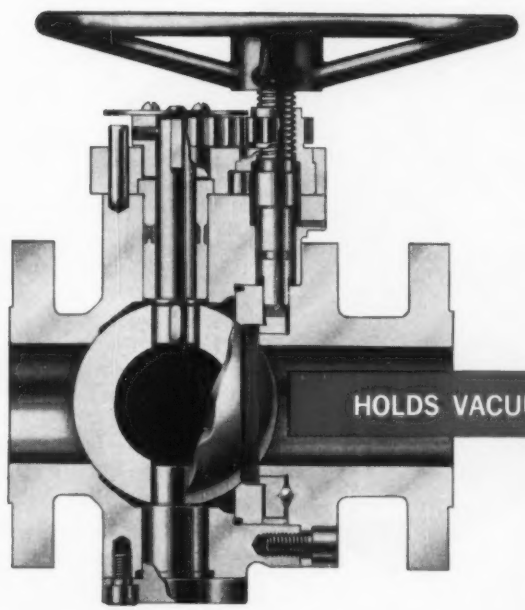
BALDWIN · LIMA · HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

For more data on advertised products, use Readers' Service Cards, last page.

Exclusive Controlled Compressible Port Seal provides fast, positive shutoff in any service...





HYDRIL BALL Type "K" PLUG VALVES

Controlled sealing . . . a new concept in valve design . . . is the secret of Hydril's tight, bubble-proof shutoff. Hydril Ball-Plug Valves always seal positively against pressure from either direction—or against vacuum—because the fully confined packing ring is mechanically compressed between plug and seat when the valve is closed. This tightly compressed gasket type seal easily bridges clearances between parts as well as surface imperfections. Result: seal efficiency is unimpaired by prolonged hard usage, by rust or sediment.

Design of Hydril Type "K" Ball Plug Valves assures minimum maintenance costs. Non-lubricated, they employ no sealing lubricants. There's no sliding friction between plug and body to produce wear and abrasion.

The spherical plug is mounted on accurately positioned bearings, maintaining a minimal controlled clearance between plug and body. This contributes to easy, free-turning operation as well as to long service life.

●

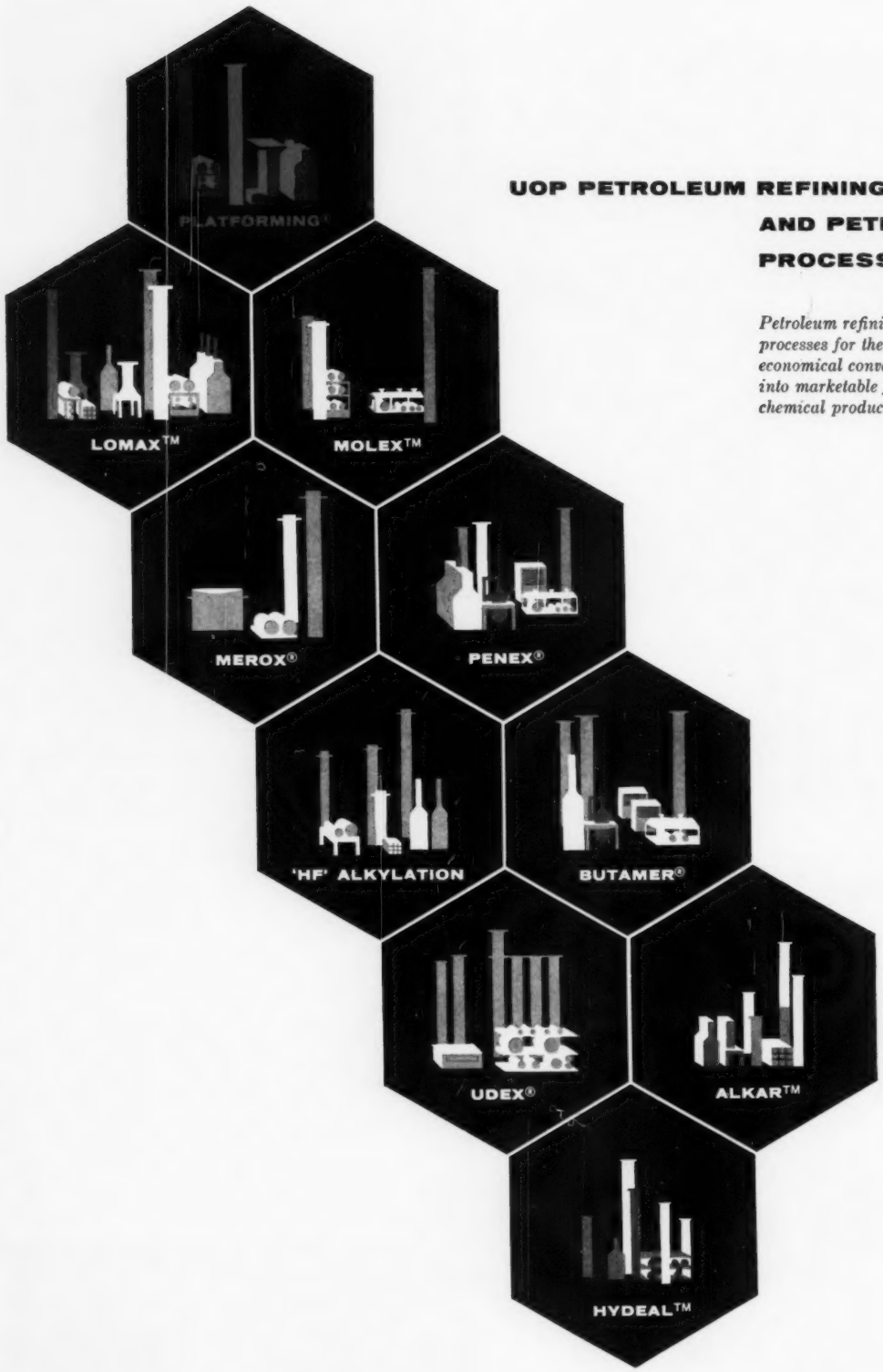
Hydril valves are available in a wide range of sizes and ratings. Worm-gear and motor-operated models can be supplied. Get the full story on Hydril Valves from your nearby representative . . . or write Hydril Company for free Catalog No. V-60.

HYDRIL COMPANY

714 West Olympic Boulevard, Los Angeles 15, Calif.

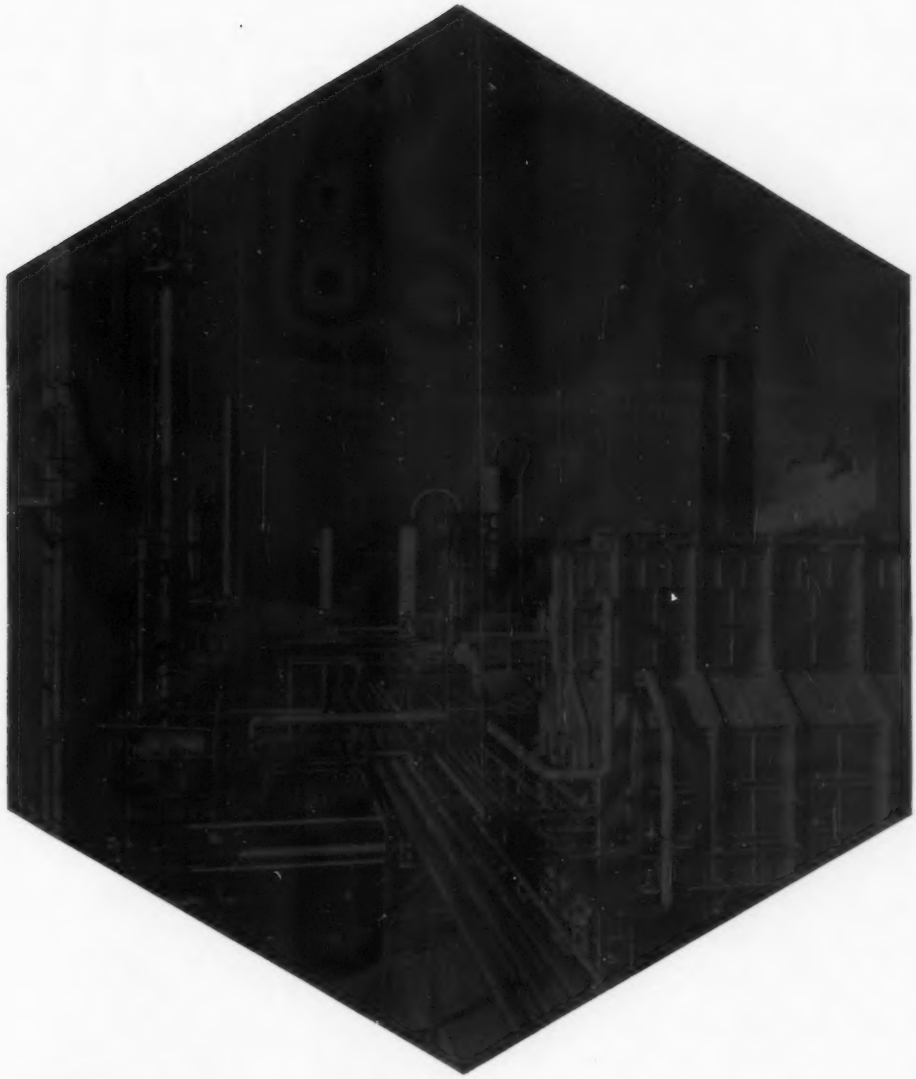
Factories at: Los Angeles; Houston, Texas; Rochester, Pa.
Sales Offices: California: Bakersfield, Los Angeles, Ventura • **Louisiana:** Harvey, New Iberia, Shreveport **Oklahoma:** Oklahoma City, Tulsa • **Texas:** Corpus Christi, Dallas, Houston, Midland, Odessa • **Wyoming:** Casper **New York:** New York • **Canada:** Calgary, Edmonton

For more data on advertised products, use Readers' Service Cards, last page.



UOP PETROLEUM REFINING AND PETROCHEMICAL PROCESSES

Petroleum refining and petrochemical processes for the efficient and economical conversion of petroleum into marketable fuel and chemical products.



meet the demand for quality gasoline with Platforming

Marketing petroleum products in the sixties promises to be a tight competitive race for quality. Processing will be pushed more and more to produce products that are of top quality, high octane and yet are profitable to produce. Platforming, designed, engineered, and licensed by UOP, produces top quality Platformate for high energy performance.

Now is the time for refiners to evaluate their processing capabilities with the proposed future demand for the better gasoline products. Platforming enables a refiner to make a larger percentage of top quality gasoline and petrochemical intermediates . . . more profitable products.

Platforming is economical to install, reliable and easy to operate. The process utilizes a platinum containing catalyst, that is highly active and hence provides a truly continuous operation. Platforming can handle the full boiling range gasolines without prefractionation, or naphtha cuts separated from them. Any refinery naphtha feed can be processed efficiently by Platforming.

With more than a score of different processes UOP can offer you the most profitable method for either employing your existing facilities or for an entirely new operation. Let UOP engineers evaluate your processing needs now.

WHERE RESEARCH TODAY
MEANS PROGRESS TOMORROW

UOP®

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

GLASS to Swagelok®

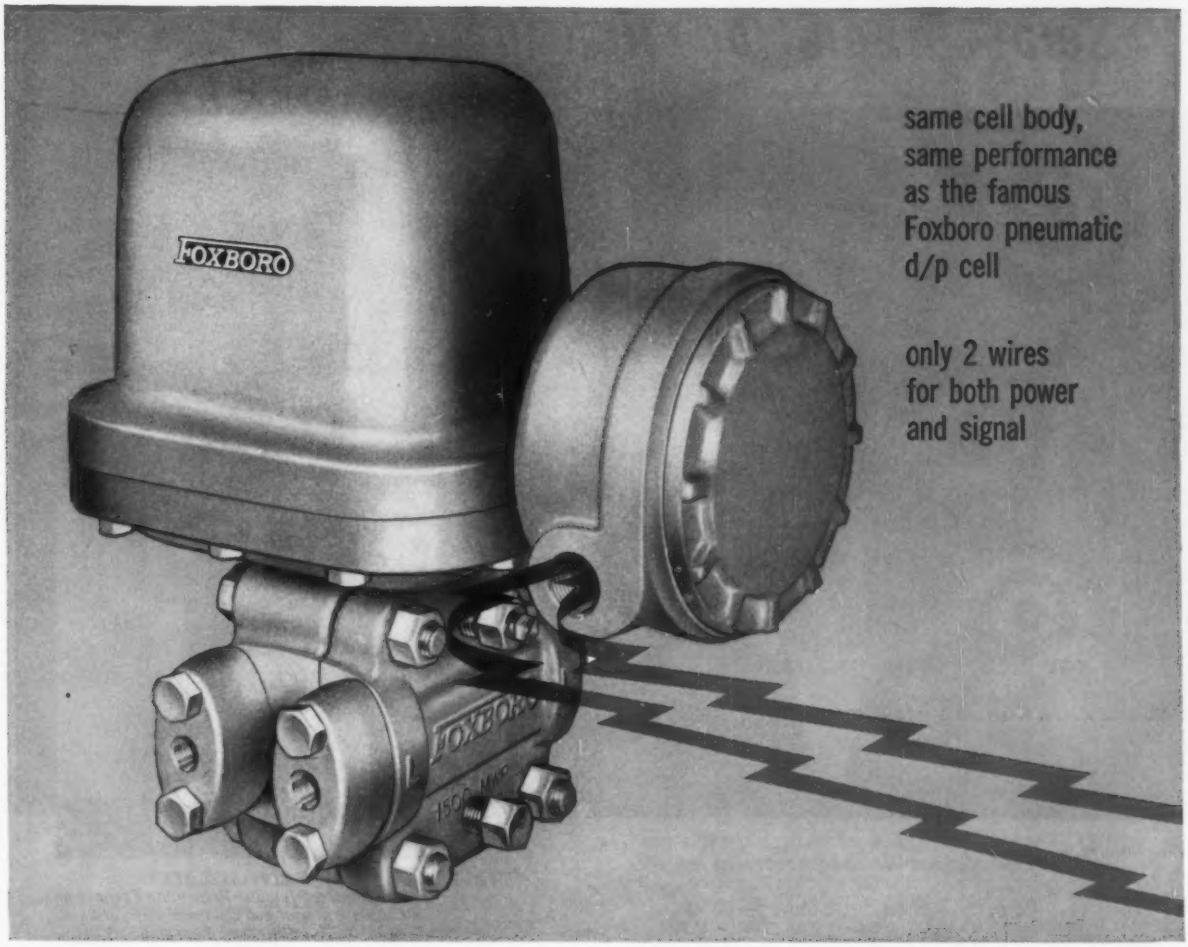
Swagelok® Tube Fittings provide a positive seal on glass tubing

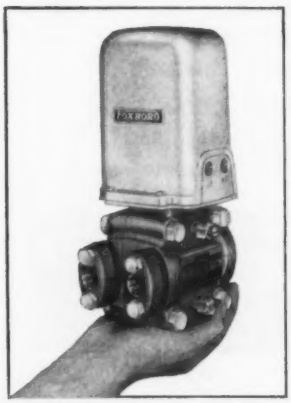
with a complete line of tube connections for laboratory work, vacuum systems and general usage. Whether your problem is connecting glass to glass, glass to metal or glass to plastic . . . any installation requiring an absolute seal on glass, plastic or metal tubing—

Swagelok® TUBE FITTINGS
SOLVE YOUR PROBLEMS

CRAWFORD FITTING COMPANY
884 EAST 140th ST. • CLEVELAND 10, OHIO
CRAWFORD FITTINGS (CANADA) LTD.
NIAGARA FALLS, ONTARIO, CANADA

introducing the Foxboro electronic d/p cell* transmitter





The Foxboro electronic d/p cell transmitter and this Foxboro pneumatic d/p cell transmitter use the identical cell body. Only the top transmitting mechanism has been changed.

Yes, Foxboro has taken its famous pneumatic d/p Cell and added the benefits of electronic transmission. It's the new Foxboro *electronic* d/p Cell transmitter. Look at the results:

- both power and signal travel over the same pair of unshielded wires — no field power supply required
- pressure, flow, and level transmission up to several miles without lag
- true force-balance design for lowest displacement — highest overrange protection
- high level 10-50 ma d-c signal provides powerful rebalancing force
- adjustable ranges from 5″ to 850″ water with external zero adjustment — working pressures of 1500 and 6000 psi

And, of course, you get the same positive overrange protection, the same high sustained accuracy, the same rugged construction that has always been standard with the Foxboro d/p cell transmitter.

If you're thinking "electronic," it will pay you to investigate this important instrument in the Foxboro Electronic Consotrol* family. Get in touch with your Foxboro Field Engineer for complete details, or write for Bulletin 21-10. The Foxboro Company, 742 Neponset Avenue, Foxboro, Massachusetts.

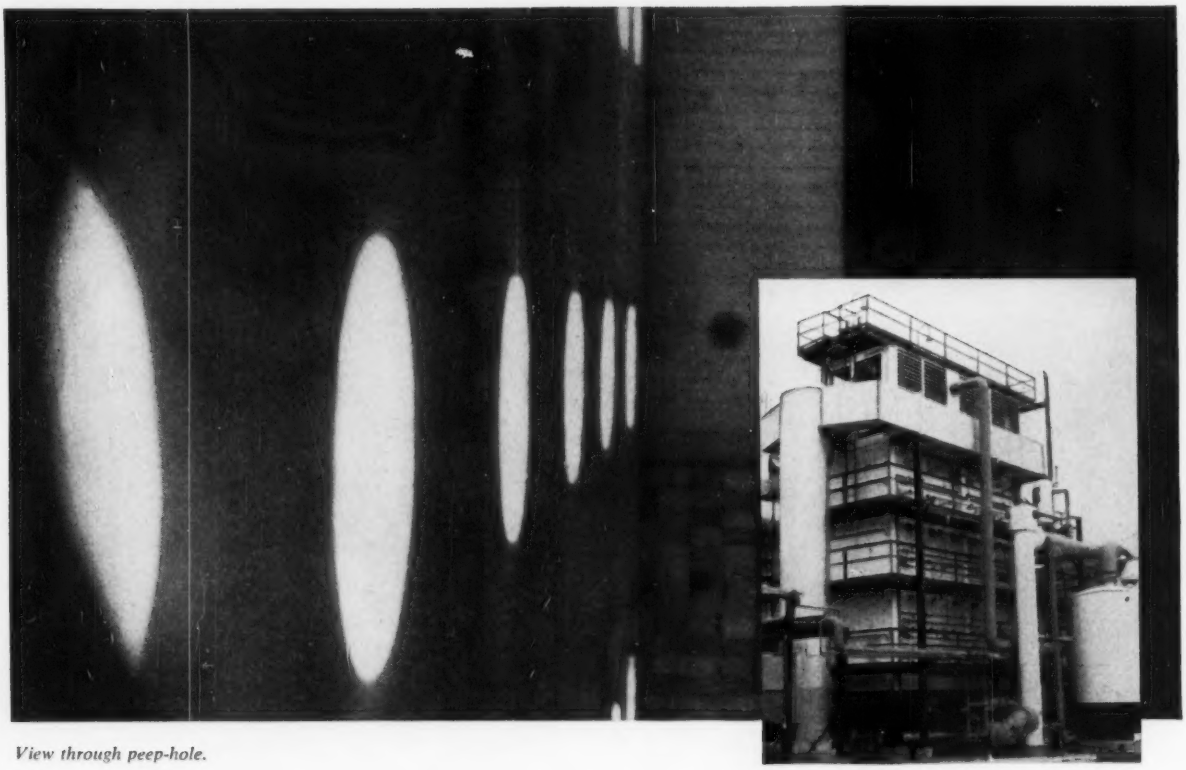
*Reg. U.S. Pat. Off.

FOXBORO
REG. U. S. PAT. OFF.

For more data on advertised products, use Readers' Service Cards, last page.

NEW SLANTS ON HEAT PROCESSING FROM SELAS

for your precise processing operations:
Selas Gradiation® Heating



View through peep-hole.

Selas Steam-Methane Reforming Furnace at Collier Carbon and Chemical Corporation, Brea, California. Duradiant burners, patterned in seven horizontal rows respond instantly to heat input required, burn with extremely low excess air (6%).

A look inside this Selas Steam-Methane Reforming furnace at the Collier Carbon and Chemical Corporation, Brea, Calif., plant, clearly demonstrates the benefits of Gradiation heating for petroleum, petrochemical and chemical processing.

PRECISENESS OF HEATING . . . complete combustion within Duradiant® burner cup permits placing burners close to tubes . . . achieving fast heat-up and instantaneous response to controller demand.

HEAT UNIFORMITY . . . even-heat distribution along and around tubes increases tube life by eliminating hot spots, minimizing coke formation.

ZONE CONTROL . . . Duradiant burners can be adjusted to desired heat pattern in either horizontal or vertical rows.

VERSATILITY . . . Gradiation heaters can handle a variety of feed-stocks, interchangeably, under optimum conditions.

These benefits apply to *horizontal*, as well as *vertical*, Gradiation tubular furnaces.

May we arrange for a Selas field engineer to discuss your heat processing needs with you? For this service . . . without cost or obligation to you . . . or for a copy of Bulletin 1043 "Gradiation Heating for Petroleum and Chemical Processing," write to Fluid Processing Division.

GRADIATION and DURADIANT are registered trademarks of Selas Corporation of America.

SELAS CORPORATION OF AMERICA
72 Dreshertown Road, Dresher, Pa.

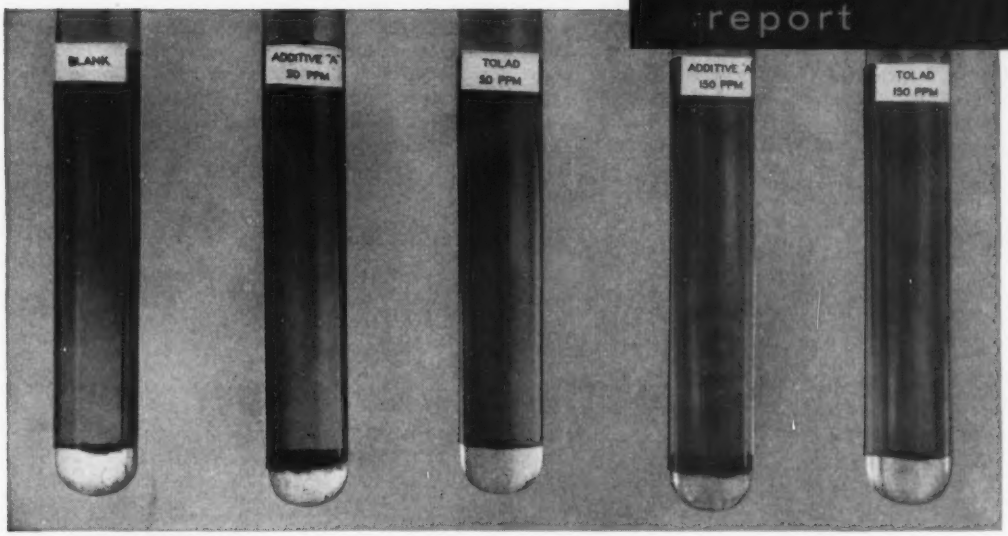
EUROPEAN SUBSIDIARY: Selas Corporation of America, European Div., S.A., Pregny, Geneva, Switzerland. INTERNATIONAL AFFILIATES—Benelux, Canada, England, France, Germany, Italy, Japan, Portugal, Spain.

SELAS

HEAT AND FLUID PROCESSING ENGINEERS

DEVELOPMENT / DESIGN / CONSTRUCTION

another
TRETOLITE SERVICE
report



TOLAD* *Fuel Additive maintains maximum water tolerance*

Compare the quantities of sludge in the test tubes. The TOLAD-treated fuel samples show much less sludge than the samples treated with a well-known competitive additive.

In the Tretolite Company research laboratories TOLAD Fuel Additives are continually compared with other commercial fuel additives. In test after test, fuels treated with TOLAD have had superior water tolerance.

WHY IS WATER TOLERANCE IMPORTANT?

When agitated, No. 2 fuel oils and diesel fuels form sludge if they contain water and insoluble residue. Some additives actually impair water tolerance.

HOW DO FUEL ADDITIVES AFFECT WATER TOLERANCE?

Additives which are primarily dispersants allow insoluble residue to form freely, but disperse it throughout the fuel. However, they also disperse any water which the fuel may contain, thus promoting emulsification, and eventually, sludge formation.

WHY DO TOLAD ADDITIVES MAINTAIN MAXIMUM WATER TOLERANCE?

TOLAD additives are primarily *inhibitors.* The normal water tolerance of the fuel is not impaired, and the residue problem is corrected by inhibition, rather than dispersion.

The use of TOLAD additives enhances marketability, and practically eliminates burner-tip fouling and filter plugging. In diesel fuel injection systems, TOLAD treatment prevents fouling, increases nozzle life.

In commercial application, TOLAD *has provided these advantages at costs under those of the additives it replaced.*

For information on TOLAD, or test arrangements for your fuel, write or call . . .

*Registered trademark of Petrolite Corporation

PETROLITE CORPORATION

SUBSIDIARY AND AFFILIATED COMPANIES
CANADA, Edmonton, Alberta • ENGLAND, London
GERMANY, Frankfurt, a. M. • VENEZUELA, Caracas

TRETOLITE COMPANY
DIVISIONS
369 Marshall Avenue, Saint Louis 19, Missouri
200 South Puente Street, Brea, California

REPRESENTATIVES
ARGENTINA, Buenos Aires • BRAZIL, Rio de Janeiro • COLOMBIA, Bogota
ITALY, Rome • JAPAN, Tokyo • KUWAIT, Kuwait • MEXICO, Mexico, D. F.
NETHERLANDS, The Hague • PERU, Talara • TRINIDAD, Port of Spain

FA-60-3A

There's a Bristol recording gauge to give optimum results on *any* pressure range—whether it's full vacuum, 10,000 pounds per square inch, or a few millimeters of mercury absolute.

And whatever type of element you select, you know that Bristol's continuing research and development program has kept it far in advance of the field . . . incorporating into it the latest improvements in instrument engineering and element metallurgy.

The product of over 70 years of instrument experience, Bristol gauges are *completely field proved*—some have been in service for over 40 years! An outstanding record! Among men who know recording gauges, it's Bristol for reliability, every time.

And check these big advantages:

Easy-change elements. Elements are designed for easy interchangeability. You can buy a gauge with any standard helical element; change later to a standard capsular element, or *vice versa*. Flexible polyethylene tubing for capsular element connections further simplifies change, speeds maintenance, and provides vibration isolation.

Extra mounting rigidity. Greater accuracy, greater reliability are assured by a rigid, cast-aluminum element mounting.

Element materials for every type of pressure measurement: Ni-Span C, 316 stainless steel, trumpet metal, phosphor bronze, and beryllium copper.

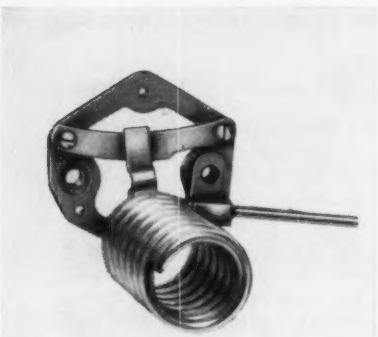
Get complete data on Bristol recording gauges, pressure elements, gauge charts and a variety of accessories in 32-page Bulletin G621. . . yours for the asking. Write: The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

What are your recording gauge requirements?

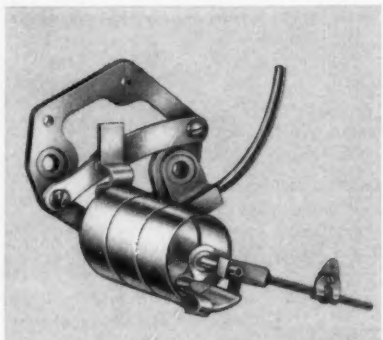
Bristol elements blanket the pressure spectrum

(0-6mm Hg Abs. to 0-10,000 psig)

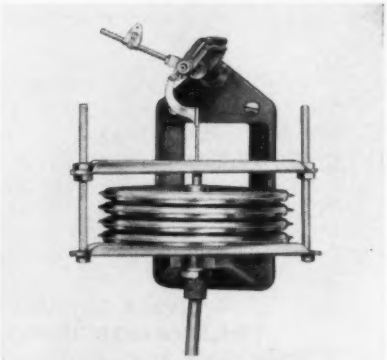
. . . another big reason that more *Bristol* recording gauges are used than all others combined!



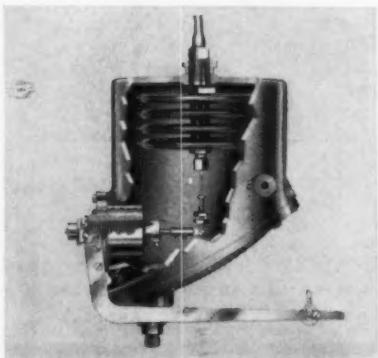
Helical element
0-500 up to 0-10,000 psi.



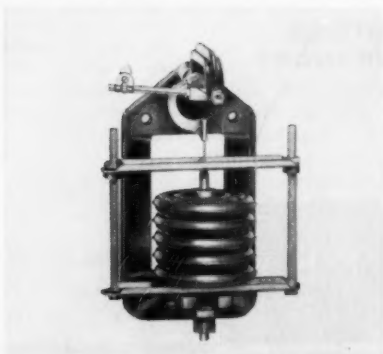
Helical element
0-30 up to 0-500 psi.



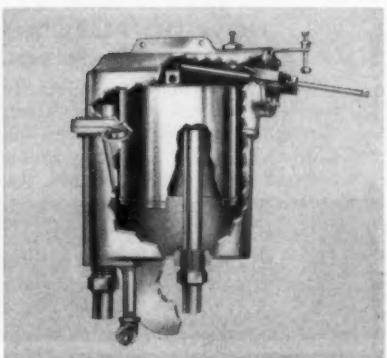
Capsular element
from 0-3 to 0-35 inches of water



Absolute pressure element
ranges as low as 0-6mm Hg Abs.



Capsular element
from 0-36 inches of water to 29.9 psi.

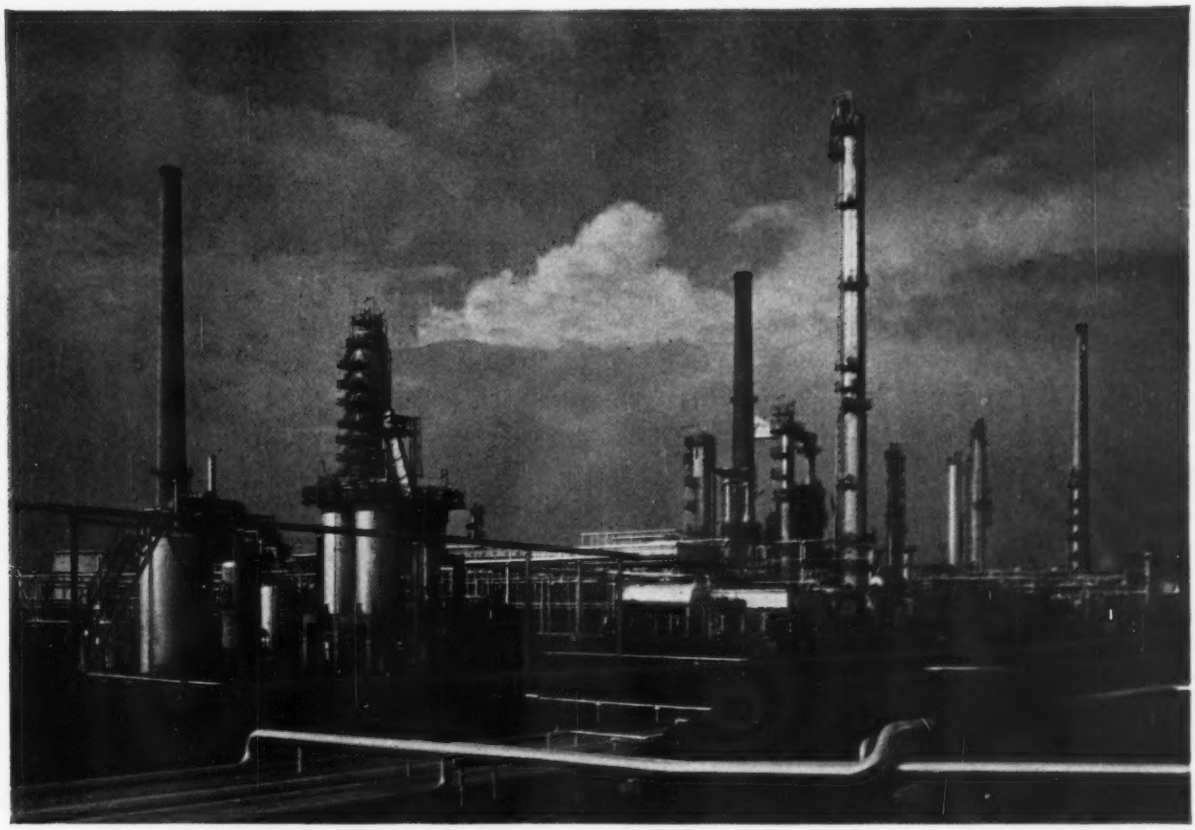


Inverted bell element
ranges as low as 0-0.2 inches of water.

BRISTOL . . . for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more data on advertised products, use Readers' Service Cards, last page.



Esso Petroleum Company, Limited, 100,000 BPSD refinery at Milford Haven, Wales. Engineering-contractor: Foster Wheeler

The Invisible 100,000 BPSD Refinery

This sky-silhouetted partial view of the new Esso Petroleum Company Limited 100,000 BPSD refinery at Milford Haven certainly appears to be quite visible. But the fact is that it is virtually invisible from the nearest highway or from the nearby sea. For important economic and civic considerations, the installation was in effect designed *into* the rolling hills of Milford Haven. Fully automated, the refinery produces gasoline and fuel oil in six process sections. As many as ten motor fuel components may be blended by remote control.

Shown above on the left are the crude distillation facilities and on the right, the powerformer processing area. A 500 million Btu/hr Foster Wheeler direct-fired heater . . . one of the largest of its type . . . serves the crude distillation unit. Facilities also include a T-shaped marine terminal extending 3500 ft. from the shore reaching a water depth of 50-70 ft. to accommodate the largest super-tankers.

To integrate this "grass roots" refinery with surrounding communities, over 75 storage tanks and spheres were placed on terraces and heater stacks were breeched into three 300 ft. main stacks to eliminate air pollution. To guard against water pollution, a separator with a 10 million gallon pond was constructed.

As in more than 800 process installations before this one, Foster Wheeler's engineering and construction services have provided the experience, ingenuity and technical competence needed to meet unusual project requirements. Here is more evidence of Foster Wheeler's ability to serve you, whatever your requirements . . . large or small . . . anywhere in the world.

Heat Engineered products, plants and processes . . . for the world's industrial progress.

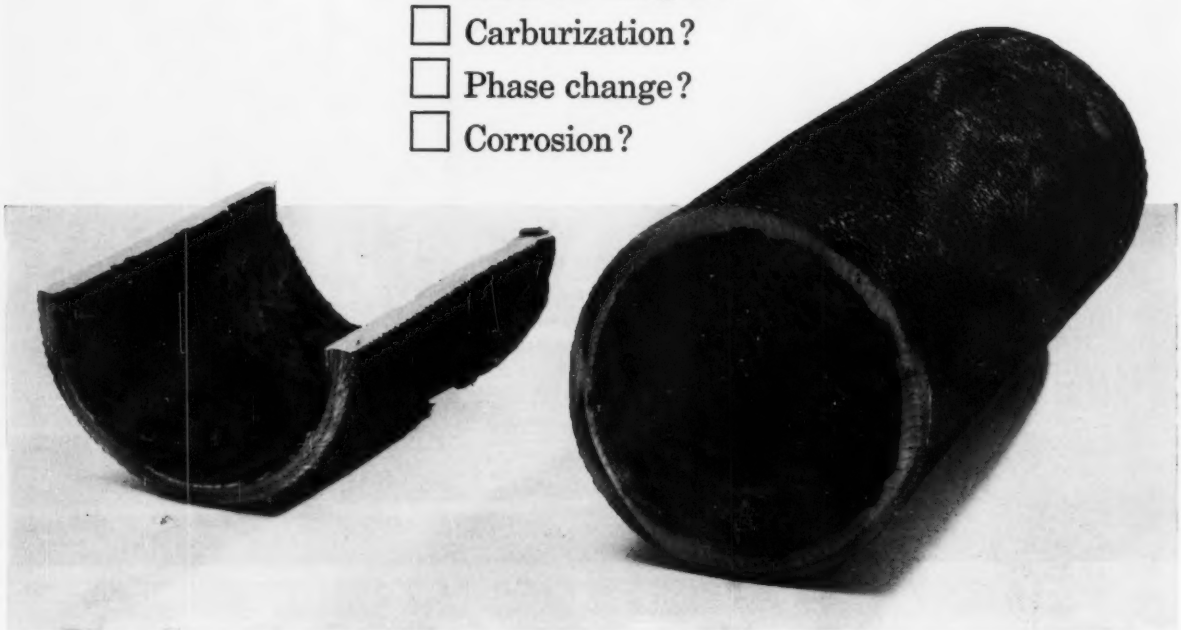
FOSTER WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

For more data on advertised products, use Readers' Service Cards, last page.

Which was the Failure Mechanism here?

- ☐ Creep?
- ☐ Oxidation?
- ☐ Thermal fatigue?
- ☐ Carburization?
- ☐ Phase change?
- ☐ Corrosion?



The selection of materials and the design of castings for high-temperature service (1200-2300° F) in refineries and chemical plants have been dictated by concentration on corrosion problems. True, corrosion problems are accelerated by the application of heat.

But corrosion did not produce the failure shown above. This failure is the result of carburization. And carburization is one of *five primary* causes of high-temperature equipment failure: creep, oxidation, thermal fatigue, carburization and phase change.

To insure longer service life from his high-temperature equipment, the corrosion engineer must concern himself with an analysis of these mechanisms as related to his specific operating conditions.

In terms of refinery and chemical plant operations, the causes and failure forms of these mechanisms are as follows:

Creep failures are caused by temperature and stress and are speeded up by temperature cycles in the operations. Creep failures manifest themselves as dimensional distortions.

Oxidation is produced by the atmosphere used in the operation and the temperature. Scaling is a characteristic of this failure.

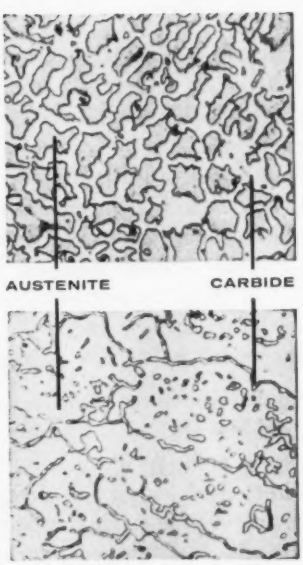
Thermal Fatigue arises from cyclical heating and cooling and thermal gradients across the metal section. The failure evidences itself as cracking and distortion.

Carburization, the absorption of carbon by the metal, occurs at high temperatures in carbonaceous atmospheres. The composition change produces lower hot strength.

Phase Changes, such as sigma formation, impair the properties of the material. Phase changes are evidenced by brittleness at room temperatures.

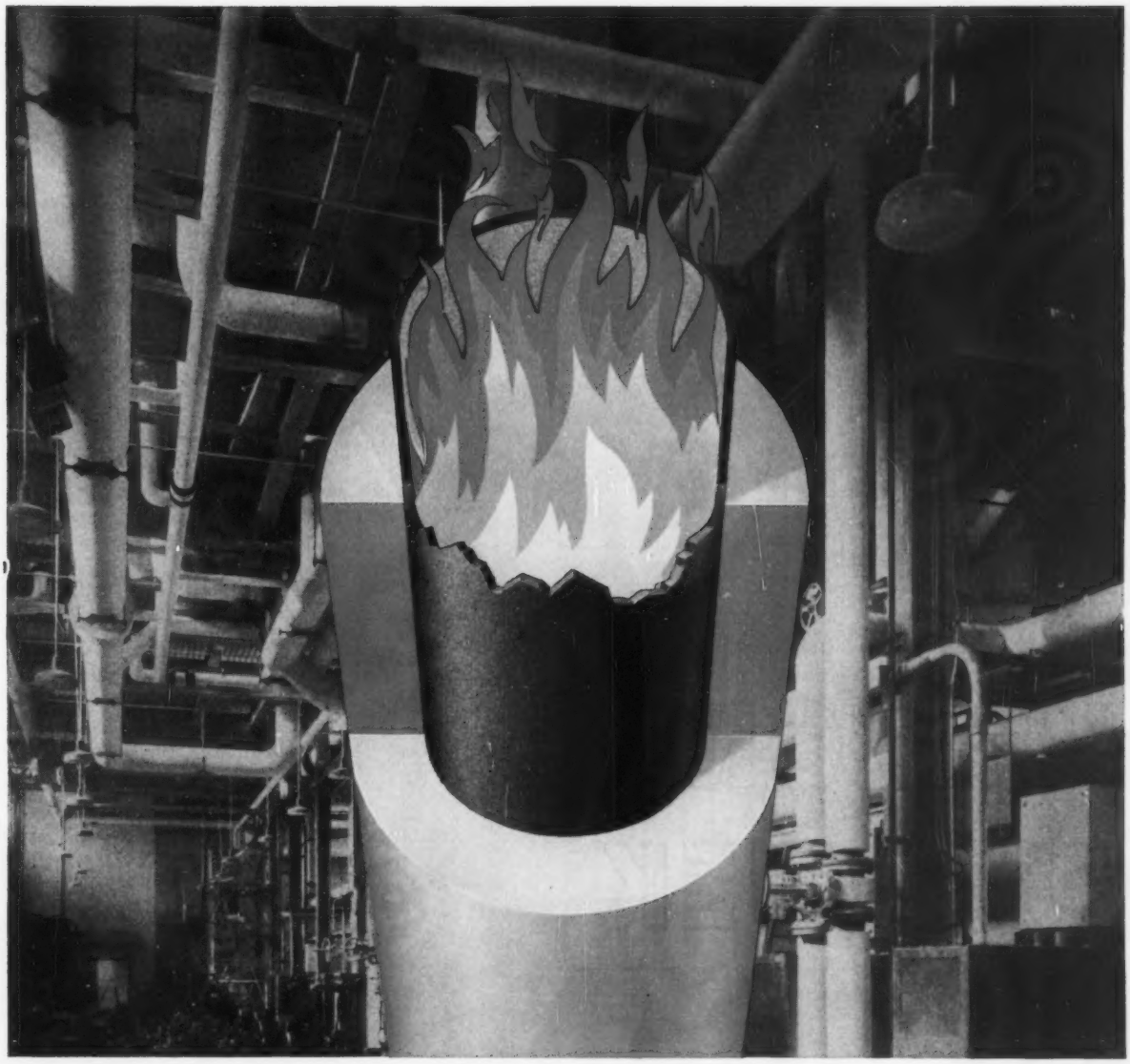
The mechanisms are interrelated and may jointly cause failure of the equipment. However, certain operating conditions at high temperatures lead to failures by one mechanism or another.

Subsequent advertisements in this series will treat each of these mechanisms in more detail and illustrate what Electro-Alloys is doing to minimize their effects.



Photomicrograph (250x) contrasts inside (top) and outside diameters of material after carburization failure.

AMERICAN Brake Shoe COMPANY **ELECTRO-ALLOYS DIVISION • Elyria, Ohio**



NEW CALSILITE-HI® HANDLES SOAKING 1800°F

Light, strong and economical, new Calsilite-Hi is ideal for both insulation and fireproofing where temperatures run over 1250°F up to 1800°F. For lower temperatures than these, Ruberoid's Regular Calsilite® insulation is recommended.

Both Calsilite and new Calsilite-Hi are molded calcium silicate insulation. They're light and easy to install. They cut and mitre quickly, smoothly. They're gentle on hands. They stay strong when wet, won't soften or fall off, return to original thermal efficiency when dry. They resist most industrial chemicals and alkalies. Available in half sectional, three segmental and block form.

For additional information, specifications, and free samples of new Calsilite-Hi or regular Calsilite insulation, mail coupon now.

RUBEROID®

Industrial Products Division PR-2
The RUBEROID Co.
500 Fifth Avenue
New York 36, N. Y.

☐ Please send technical bulletin with specifications
☐ Please send sample of Calsilite-Hi
☐ Please send sample of regular Calsilite

Name_____

Title_____

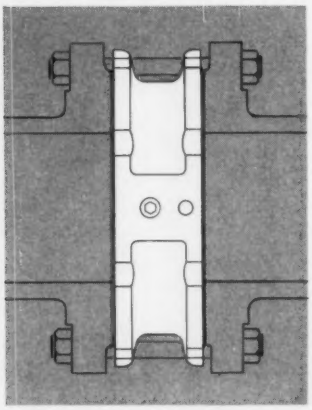
Company_____

Address_____

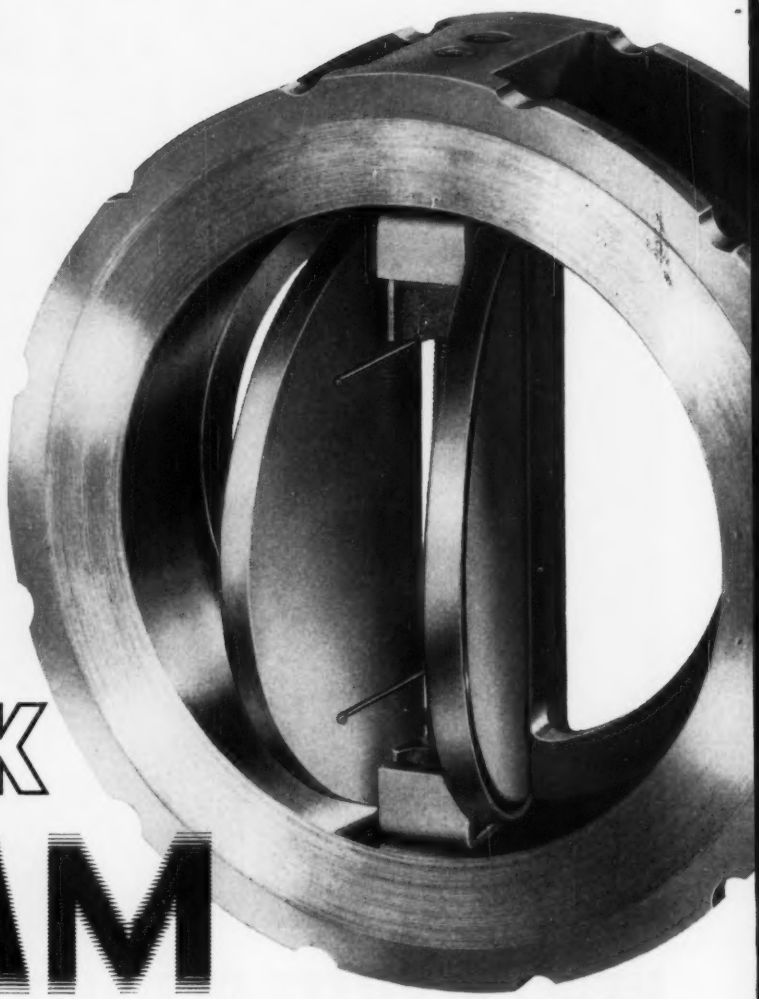
City_____ Zone___ State_____

For more data on advertised products, use Readers' Service Cards, last page.

The Duo-Chek® is easily lowered into position between the flange faces; because of its light weight, special handling equipment is unnecessary. Fits standard valve flanges. In sizes 2 inch through 12 inch, one valve fits series 125, series 150 and series 300 flanges, saving inventory at less cost than a conventional 150 series. The machined outside diameter centers the Duo-Chek between series 300 flanges; the slots center it for series 150 flanges.



SEE THE DUO-CHEK
Booth 222
1961 PETROCHEMICAL & REFINING SHOW
New Orleans



PAT. PENDING

MISSION DUO-CHEK NO SLAM CHECK VALVE

If your check valve problem is water hammer, Duo-Chek is the answer. If it's weight, maintenance, mounting position, or cost, Duo-Chek is still the right answer. The Duo-Chek performs all regular check valve duties, yet weighs only ten per cent as much.

The spring loaded, light weight sealing plates operate in any position—even in vertical lines with downward flow. The stainless steel coil spring effects positive sealing action. The quick action of the spring closes the valve before reverse flow can occur; therefore, no slam, no water hammer.

Duo-Chek valves come in a complete range of end connections and sizes from 2 to 48 inches, for ASA pressure ratings of series 125 through 2500, and for temperatures to 1400°F. They are made in steel, stainless steel, aluminum, and bronze. Sealing materials are Buna-N, Teflon, Viton, or metal depending on your service.

MISSION VALVE AND PUMP CO. A SUBSIDIARY OF MISSION MANUFACTURING CO. P. O. Box 4209, Houston, Texas • Cable Address "MISSCO" Export Office: 30 Rockefeller Plaza, New York • In the United Kingdom: MISSION MANUFACTURING CO., LTD., 1 Hanover Square, London W. 1 England • Cable Address "MISSOMAN" • Sold by Mission Manufacturing Company outside of Canada and the U.S.A.

MISSION VALVE AND PUMP CO.

Struthers Wells FIRED HEATERS

The heater above is installed in the refinery of a leading Mid-Continent oil company. Extending to a height of 150 feet, the heater is one of the largest of this type ever built.

Designed for high thermal efficiency, the heater is used on isobutane stripper reboiler service. Dual fuel burners allow the use of a wide range of fuels. Special wind boxes are provided to reduce burner noise level to a low figure.

This heater is typical of the wide range of equipment offered for standard and special requirements, including the highest commercial temperatures. Many special systems have been constructed for unusual requirements. Waste heat boilers and economizers for reclaiming heat from high temperature gases have also been supplied.

For additional information and address of your local Struthers Wells representative, see Chemical Engineering Catalog, pages 1523 to 1542.

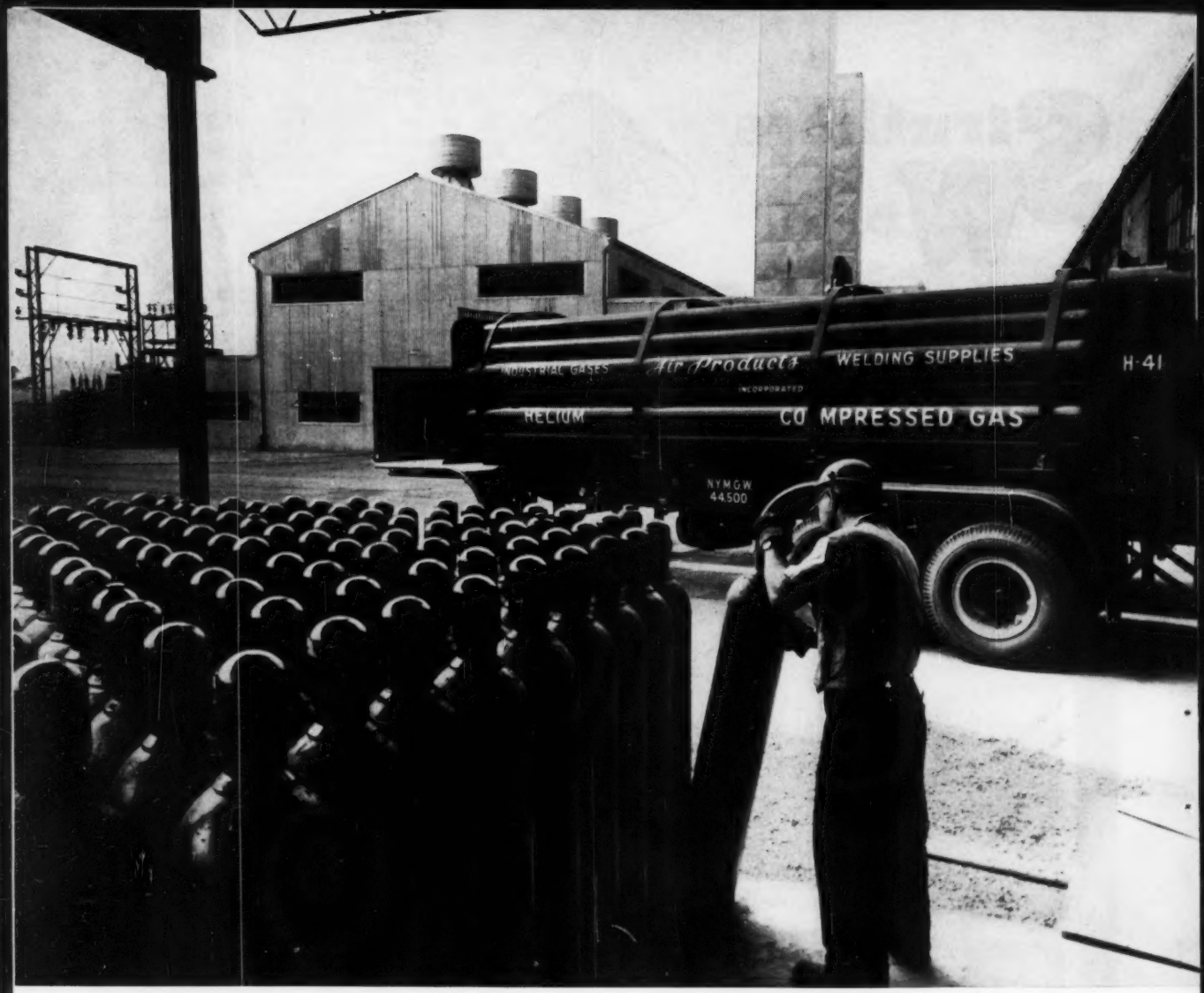
STRUTHERS WELLS CORPORATION
WARREN, PENNSYLVANIA
Plants at Warren and Titusville, Pa.

PROCESSING EQUIPMENT DIVISION
Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels.

BOILER DIVISION
BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION
Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

For more data on advertised products, use Readers' Service Cards, last page.



Air Products Inc., one of America's leading manufacturers of industrial gases and producers of cutting and welding equipment, uses Taylor-Wharton Gas Transports as part of their industrial gas distribution system.

And no wonder.

Low initial cost, extreme mobility and economical storage make Taylor-Wharton Gas Transports ideal for the bulk transportation of compressed gases as well as for semi-permanent storage.

Many other of the nation's gas producing, oil refining, petrochemical, food and electronic companies now employ flexible, mobile gas transports.

Why don't you? Write to:

More than a Century in Harrisburg 2, Pa.

HARRISBURG STEEL CO.

Division of HARSCO CORPORATION

This bubble-tight seal

can't cause contamination... costs nothing to maintain!

Stockham's NON-LUBRICATED Wedgeplug*'O-SEAL' Valve

Meet the valve that gives you permanent, absolute shut-off without sealing compounds or lubricants. The valve that eliminates the danger of contamination resulting from excess lubricant being forced into the product stream. Eliminates the danger of product mixing in manifolds.

The valve is Stockham's NON-LUBRICATED Wedgeplug "O-Seal" — now widely used in general purpose services. Two Teflon† "O" rings in the plug provide the pressure-seal—provide permanent "bubble-tight" shut-off in all cases.

The "O-Seal" is guaranteed not to stick . . . provides double-block and bleed in most services . . . has flawlessly machined metal seats to provide shut-off in case of fire.

*Patented — †Teflon, Dupont Trademark

Call your Stockham Distributor or Sales Representative now, or write Stockham for complete details about the "O-Seal."

Complete ranges of sizes and types available.

CAST IRON-MALLEABLE AND DUCTILE IRON PIPE FITTINGS — BRONZE, CAST IRON, DUCTILE IRON, CAST AND FORGED STEEL VALVES.

SOLD ONLY THROUGH DISTRIBUTORS

WEDGEPLUG VALVE COMPANY

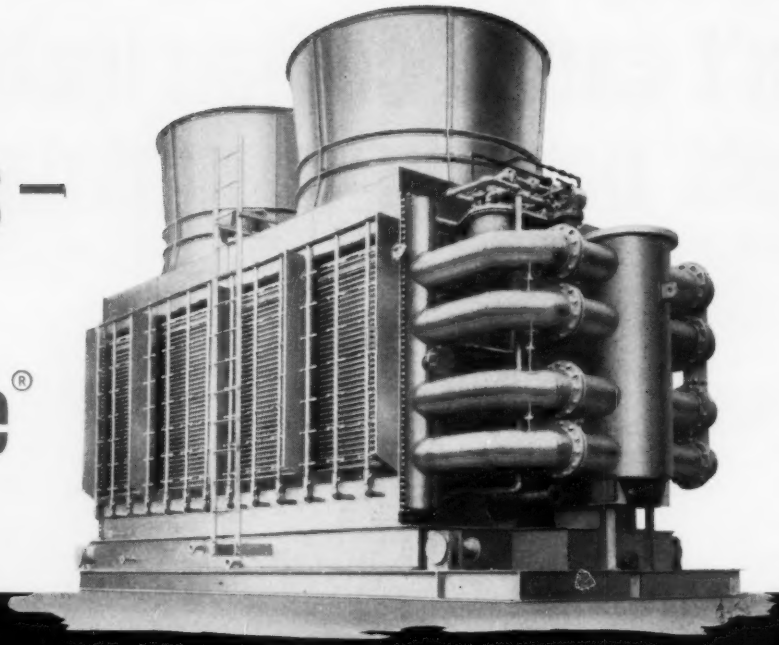
Division of

STOCKHAM
VALVES *and* FITTINGS

General Offices and Plant

4003 North 10th Avenue • Birmingham 2, Alabama

Here it is — the Aquadyne®



The latest addition to our family of tried and proved products

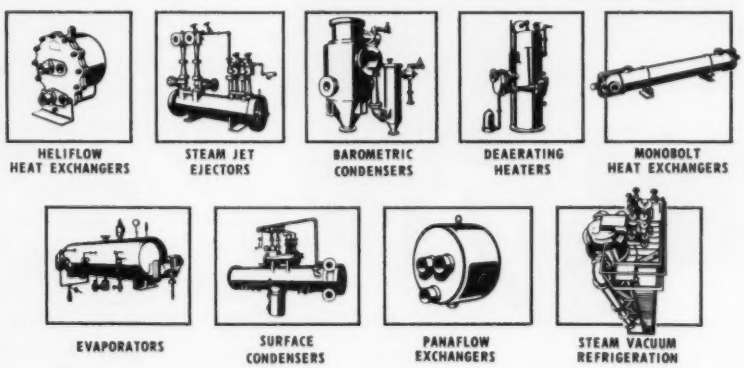
It represents the most modern concept of an evaporative condenser. If you have a cooling water problem and require a surface condenser on any vacuum system, don't overlook the **Aquadyne,** since it uses no external source of water.

And—if you want really cold water—we offer you a Steam Vacuum Refrigeration System equipped with an **Aquadyne**. Here is a means of providing large quantities of cold water down to 35° F and, as stated above, requires no external source of cooling water. No expensive refrigerants—no compressor—no extensive maintenance

See our booth No. 212 at the 1961 Petrochemical and Refinery Exhibition in New Orleans, February 26 to March 1.

SINCE 1936

Other Graham Precision-Built Products



HELIFLOW HEAT EXCHANGERS | STEAM JET EJECTORS | BAROMETRIC CONDENSERS | DEAERATING HEATERS | MONOBOLT HEAT EXCHANGERS

EVAPORATORS | SURFACE CONDENSERS | PANAFLOW EXCHANGERS | STEAM VACUUM REFRIGERATION

GRAHAM MANUFACTURING CO., INC.

Heliflow Corporation

170 GREAT NECK ROAD • GREAT NECK, NEW YORK

Offices in principal cities and Canada

NOW

competitively priced!

NEW

Aeromaster

INDUSTRIAL COOLING

FAN

featuring "QUICK-SWITCH" BLADES

Blades can be installed after hub is mounted on drive shaft

Performance, construction, and price make this the "best buy" in industrial fans! Delivers more CFM with *less* H.P. Features a ductile iron hub, removable blade retention caps, heat treated aluminum alloy blades with constant chord width and flanged ends. 4, 6 and 8 bladed fans available in 54" to 120" diameters. Maximum tip speed is 15,000 ft./min. Easy to install . . . easy to maintain. For complete details, write: KOPPERS COMPANY, INC., 5102 Scott Street, Baltimore 3, Md.

KOPPERS Aeromaster Fans

Engineered Products Sold with *Service*

The Mail Box . . .

Caught In Greece!

In the "How To Do It" article "Water Data Solve Fluid Flow Problems," by B. Kouzel (Nov. 1959 PETROLEUM REFINER) there is a slight numerical error in the algebraical transformation of equations.

On page 315, it is written:

$$F_{Q,V} = \frac{1}{F_{\Delta P}{}^{.184}}$$

However, the correct equation is:

$$F_{Q,V} = \frac{1}{F_{\Delta P}{}^{.543}}$$

Fortunately, the nomograph itself on p 312 is correct.

Alexander T. Vrionis,
Aspropyrgos (Attiki), Greece

Author's Comments

The correction is quite in order.

Luckily this relationship occurred to me after the nomograph was constructed to it and was not a major error.

It is flattering to know that my article as well as your magazine is read overseas and that someone was interested enough to check my mathematics.

Bernard Kouzel,
Anaheim, Calif.

Praise from Endacott

An article by Dr. W. A. Cunningham on "You Can Create a Professional Spirit" (PETROLEUM REFINER, May 1960, p 256) has drawn high praise from Paul Endacott, president of Phillips Petroleum Co., Bartlesville, Okla. His views were expressed in a letter to the author, who is connected with the Chemical Engineering Department, University of Texas, Austin, as follows:

"I read with a great deal of interest your article on 'You Can Create a Professional Spirit' in the Petroleum Refiner Magazine. It is the best thing of its kind I have ever read on this subject and you are to be sincerely congratulated for so clearly setting forth the pertinent aspects of the problem. I wish I had encountered this article before I assembled my comments for Boston because I know I would have been tempted to steal some of your stuff.

"I am taking the liberty of passing the reprint around to several other of our people who are interested in this subject."

Errata

Here's an author to add to PR's Annual Editorial Index (Dec. 1960):

FAIR, JAMES R. What You Need To Design Thermosiphon Reboilers ..... Feb. 105

Entries in the Subject Index already include this item.

SADI

VALVE OPERATORS

Adaptable to NEW and EXISTING VALVES

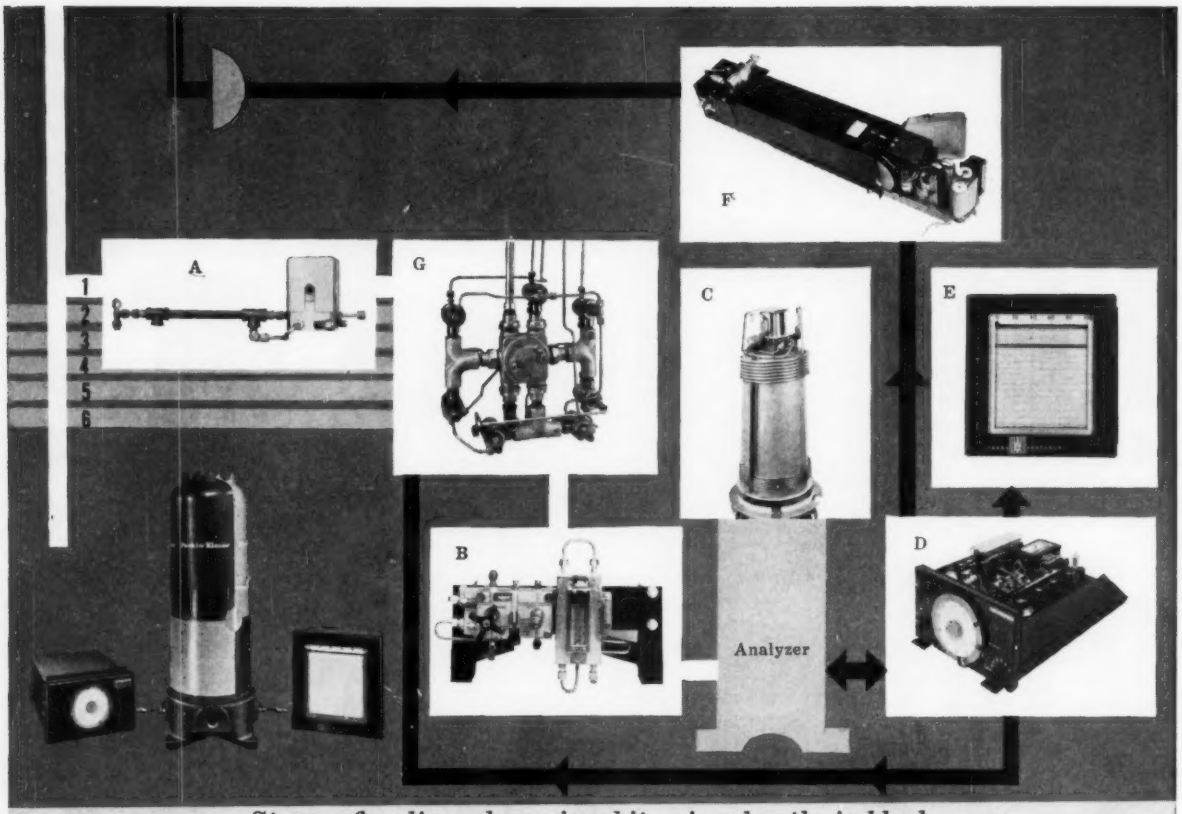
THOUSANDS of operators in service throughout the world, typical examples of SADI power transmission equipment quality

SADI

HAULAGE CAPSTANS

TRANSPORTABLE ECONOMICAL DEPENDABLE

SADI S.P.R.L.
4, RUE CARBURANTS
BRUSSELS 19 — BELGIUM



Stream flow lines shown in white, signal paths in black

This block diagram shows how six process streams can be selectively analyzed by the P-E Model 184-B. For brevity, Stream #1 only will be followed through the system.

Stream #1 is tapped, and the sample vaporized in the Liquid Sample Vaporizer (A). Sample #1 then flows (with the other five vaporized samples) into the enclosed, heated Multi-Stream Solenoid Switching Manifold (G). The solenoids are electrically directed by the Programmer (D). As it is selected, Sample #1 is valved into the Final Sampling Assembly (B), where it is filtered and metered into the Analyzer. The Analyzer quantitatively and qualitatively separates the sample's components by gas chromatography, produces signals which appear as a bar graph on Recorder (E).

The signal can also be fed into a Pneumatic Control Accessory (F) which produces a 15 psi signal for automatic control of one variable component of the stream.

The Analyzer with Reverse Flow Valve (C) allows for the analysis of light components individually plus a "total heavies" measurement; it back-flushes and analyzes heavy ends as a single peak, shortening analysis time in the process. The Programmer (D) is available in a variety of modes for multi-component and multi-stream analysis. It controls the Switching Manifold (G) and the Analyzer, and the readout of the Recorder (E).

All flow lines and sampling building blocks are kept above the dew point, where necessary, by steam tracing.

UNTIL NOW—PROCESS CONTROL INSTRUMENTATION LIKE THIS HAD TO BE CUSTOM-BUILT

Standard building blocks give the new P-E Model 184-B Process Vapor Fractometer the flexibility of the most advanced special engineering developments in process gas chromatography.

A new, highly versatile instrument, the Model 184-B brings automatic process control by gas chromatography within the reach of virtually any petroleum or chemical processing plant.

The Model 184-B uses *building block* sampling and sensing units in various combinations to produce process analytical systems which mean continuing extra dividends through reduced maintenance, low-cost training and highest reliability.

These standard building blocks include multi-port sampling valves for backflushing and analyzing heavy ends . . . versatile multi-column systems . . . multi-stream programmer kits . . . pneumatic units for automatic control . . . and a wide variety of sampling devices.

Perkin-Elmer, the world's largest manufacturer of gas chromatographic instruments, will help you in your process instrumentation requirements. For more information, write for a new descriptive booklet.

All building blocks in any P-E system conform to standard refinery and chemical plant safety practices.

Talented engineers and physicists at all levels interested in development of commercial laboratory scientific instruments find great reward at Perkin-Elmer. Please write or call Mr. Howard Moran.

INSTRUMENT DIVISION

Perkin-Elmer *Corporation*

NORWALK, CONNECTICUT

For more data on advertised products, use Readers' Service Cards, last page.

The project engineer is responsible for the success and on-time completion of a process industry construction job.

The most difficult task facing a project engineer is that of being sure that he has the answers to all of the queries pertaining to the project at the proper time. One of his most useful tools is a set of checklists which he uses to stay ahead—by having the answers to the important questions.

This special report contains a set of checklists which will aid project engineers in collecting data so that they will be prepared to answer those pointed questions about the project at the correct time.

Another phase of project management that the project engineer and management must know is just where the project stands at all times. This is answered by the Project Status Report. By understanding the implications of these reports, engineers and management can take corrective action before the project gets out of hand.

PROJECT MANAGEMENT SPECIAL REPORT

Now a checklist to make sure all the tough questions have been answered before a project contract is let

To Engineering-Contractors: A Checklist for Project Engineers

A project can be divided into two general parts— Phase 1: Pre-Contract Stage, Phase 2: Project Organization and Execution

THERE IS NO SINGLE, SIMPLE solution to follow for any major engineering effort, such as a process plant, since each plant and contractor will have somewhat different methods. The most difficult projects for the contractor are those with an inexperienced customer. The most difficult projects for the owner are those agreements placed strictly on a price basis, without regard to the background or abilities of the contractor. Most of the problems and misunderstandings of either the contractor or the customer can be avoided by careful and complete inquiries and proposals.

Phase 1—The Pre-Contract Stage. Contracts may be entered into for completion of all or various parts of Phase 1, such as initial laboratory or pilot plant studies, an economic study or justification and preparation of detailed specifications and descriptions for an inquiry. Preparation of all necessary data for inquiring a major process plant may consume several thousand manhours. This is usually the reason for employing an outside engineering firm for the preparation of an inquiry. As shown in the Phase 1 chart, the engineering firm retained to prepare the inquiry sometimes may also offer a proposal for the project in competition with other firms. A contractor's Proposal or a customer's inquiry for a process plant will usually include the following:

1.0 Process Description. Material and other balances. Utility requirements. Generalized flow sheets.

2.0 A plot plan showing the general boundaries of the various process areas (or the single area). The location of major equipment.

3.0 Equipment Specifications.

4.0 Design Specifications for all parts of the installation which come under the National (U.S.) Codes of design and manufacturing practice. Large plant operators generally reproduce parts of their standards for inquiries. Nearly all large engineering contracting firms have standardized specifications which with a small amount of changing will be applicable for the particular process.

5.0 Outline sketches and specifications for pressure vessels.

6.0 Specification sheets for heat-exchange apparatus, heaters, instruments, etc.

7.0 All other miscellaneous information such as tools, construction equipment, consumable supplies, site preparation, labor requirements, field organization charts etc.

Contract Estimates. Nearly any proposal must be based on some type of estimate. The exception is usually where the work or installation is incompletely defined but of such urgency that time will not permit a complete and detailed proposal to be prepared.

Preliminary agreements may be entered into permitting the early parts of the work to proceed on a unit cost basis up to some cut-off date, at which time the contractor must submit a complete estimate. Ob-

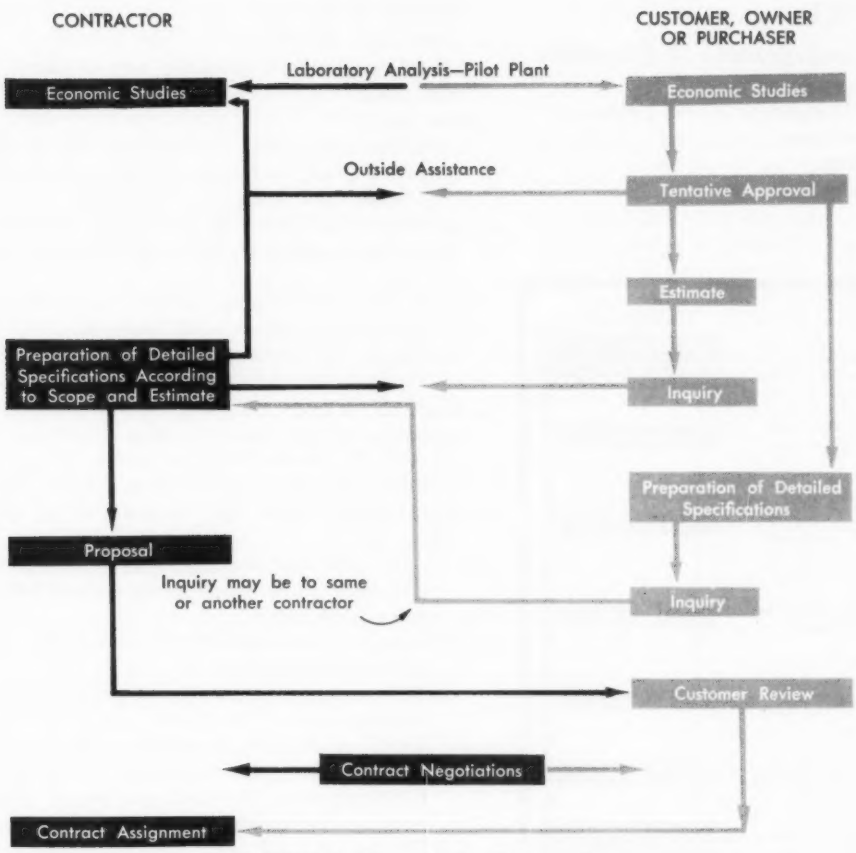


FIGURE 1—Phase 1—Pre-Contract Stage

viously innumerable types of agreements may be entered into. Much depends upon the owner or customer, the type project, his contracting experience and the type of contractor used.

The completed project estimate is one of the requirements for completion of a schedule since the estimated manhours for each function indicate the manpower requirements and time for completion.

Contract Budget and Cost Control. The contract estimate is also the basis for the contract budget. Nearly all contracting organizations establish specific itemized manhour and material cost budgets for each step or item. The material (and equipment) budgets are used as a guide for procurement. All other functions in Phase 2 (organization and execution stage) are budgeted so that engineering and other technical costs can be anticipated and controlled.

Field construction costs are closely studied and regularly reported. Some contracting firms use computer methods to keep a constant check on all construction costs. This method is not only useful for the particular project, the accumulated statistics provide reliable data for future work.

Construction Questionnaire. The construction questionnaire is generally completed during Phase 1. It is primarily a check list to be used in resolving as many questions as possible in the shortest time. Such lists are often very useful as agendas for pre-contract and later meetings between the customer and the contractor, avoiding much of the wasted time caused by a lack of specific items. A detailed list is also useful for the customer since he can thus anticipate questions and they may be answered in the inquiry.

There is a considerable difference in the questionnaire for a domestic project within an operating plant, a domestic project which starts from the "bare-ground" or a "grass-roots" project, and the several types for foreign work. Although most of the questions are included, generally a very complete and detailed questionnaire should be required for each project using the basic questions and including those which are applicable to the new work.

Construction survey forms are check lists which attempt to anticipate all possible questions with respect to a project, with the exception of process data or information.

Construction Survey—Domestic.

Estimate No. _____

Contract No. _____

1. Customer_____

A SPECIAL REPORT

To Engineering-Contractors: A Checklist

Address_____ Telephone_____ TWX_____
Customer's Representative_____
Executive or Proj. Eng.
Names of customer's tech. personnel

_____

2. Jobsite location_____

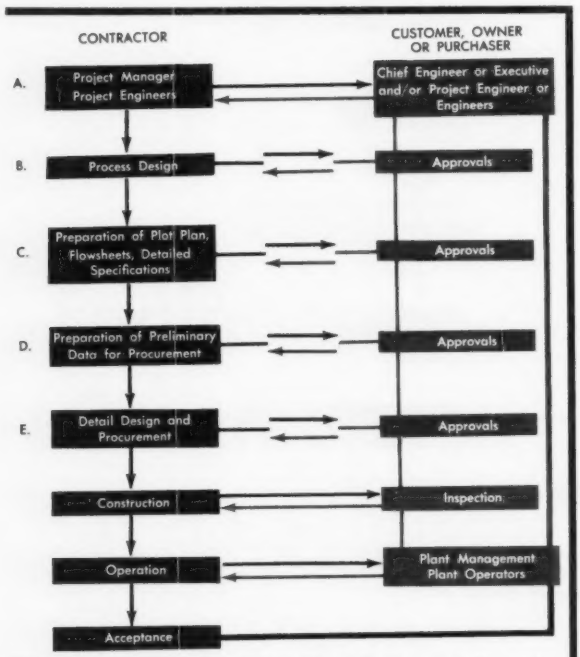


FIGURE 2—Phase 2—Project Organization and Execution

TABLE 1—Steps in Phase 2

Process Design
- Economic study—payout. By contractor or customer
- Process studies
- Equipment sizing (idealized)
- Process flow sheets (block diagrams)

Preparation of detailed specifications, etc.
- Detailed flow sheets. Major equipment lists
- Selection of equipment by specification
- Completion of all general specifications, plant layouts

Preliminary data for procurement
- Finalization of equipment according to commercial practices
- Production of data for procurement. Major equipment

Detail design and procurement
- Preparation of all drawings
- Listing of materials
- Procurement steps, inquiry, proposal analysis, vendor selection, release of purchase orders, expediting, inspection

Construction
- Site preparation
- Underground phases
- Foundations
- Equipment erection

Shipping address_____

3. Type Exist. Plant_____ Bare Ground_____
4. Brief Description of proposed unit or plant installation.
5. Site area.
   - 5.1 Clean and graded. (State if site will be fenced and if it will be furnished clear and graded). Obtain and complete following:
   - 5.2 Plant Map, Area Map, Contour Map
   - 5.3 Locate existing sewers or drainage or ditches (see 12.7).
   - 5.4 If site is to be prepared by others, obtain details of preparation (specifications).
   - 5.5 Check surrounding area for drainage if area contour map is not available.
6. Plant access and construction personnel traffic. If roadways are not now available determine when they will be provided and by whom. If new work is within an existing plant obtain plant map and mark entrance gates and roadways to be used by contractor:
   a) for personnel use; b) for material transport; c) recheck 5.1 above as to whether or not work area will be fenced.
   - 6.1 Check if personnel private auto traffic will be permitted into plant.
   - 6.2 Will personnel parking lot be provided? Obtain location.
   - 6.3 Check plant pass procedure. Badges, Time clock. Security Requirements. A separate gate for construction personnel and fenced construction area is desirable.
   - 6.4 Obtain copy of plant personnel safety regulations. Establish smoking areas, rules applicable to construction personnel, use of matches, lighters etc. See 20.0 for other safety requirements.
7. Material Handling, Storage. Indicate location on plant map of storage area to be used by contractor. If "grass roots" plant, areas will be designated on general plot plan. If storage area is within a plant area will storage area be fenced.
8. Material Delivery.
   - 8.11 Railroad. Names of carriers. Maximum weight, dimensions set by R.R.
   - 8.12 R.R. switching service. Determine availability.
   - 8.13 Spur track. Check existing spur track, if any. Determine if temporary spur track will be necessary, and whether to be provided by contractor. Establish most acceptable location. Determine switch point. Determine ground conditions in area where track will be laid, whether aggregate or other fill required.
   - 8.2 Truck Delivery. Obtain names of carriers. Junction points if any.
   - 8.3 Highway. Determine nearest highway and/or connecting road way. If not a major highway check condition, whether or not bridges exist, weight and dimension limitations.
   - 8.4 If work is within an existing plant, determine customer's procedure for materials entering and leaving plant. If separate gateway is provided and contractor's areas fenced, problems in this respect may be simplified.

8.5 Establish different requirements for contractor's equipment or tools.

9. Mail Service. Nearest post office. A separate mail service and P. O. box than customer's is desirable.

10. Communications. Telephone. Teletype, Western Union WUX. Determine time required for installation, costs etc.

11. Nearest City. If a major city is near, within 25 miles, determine availability of heavy construction tool rental. Rental arrangements, per month, per day, as used. Machine Shop services. Miscellaneous supplies are generally available in any major city. Dependent upon customer's and contract requirements, obtain list of acceptable suppliers, subcontractors from customer.
    11.1 Check availability of craftsmen, housing, trailer camp sites, bus and other transportation service. If grass-roots plant, it may be necessary to provide housing, trailer park, various accommodations for construction personnel.

12. Weather. (May be obtained from district U.S. Weather Bureau Office).
    12.1 Maximum-Minimum Temperature. Average Monthly temperature. Usual frost months. Frost line, if in low temperature zones.
    12.2 Maximum and yearly occurrence, rainfall.
    12.3 Maximum and yearly occurrence, snow.
    12.4 Maximum direction wind. Maximum velocities. Tornado or hurricane frequency.
    12.5 Earthquake.
    12.6 Highwater or flood stage if near major stream.
    12.7 Run-off. May be computed from 5.0 and 12.2.

13. Construction utilities, services.
    13.1 Power 13.11 Steam (pressure, service line size).
    13.12 Electric power (voltage, Maximum KW available).
    13.13 Gas fuel (pressure, line size).
    13.2 Water 13.21 Drinking. If not available check costs of temporary well or municipal supply if near city.
    13.22 Construction water for concrete, testing.
    13.23 Service line size if available.
    13.3 Air. If supplied by customer check line size and availability.
    13.4 Sewers. Check sanitary service or use of portable units.
    13.5 Connections. Determine who shall furnish valving, circuit breaker, transformer and points of connection if utilities supplied by customer.

14.0 Construction Buildings, temporary and permanent.
    14.1 Number and size buildings to be furnished and by whom.
    14.2 Check possibility of use of permanent plant buildings (grass-roots plant) during construction.
    14.3 Check if customer interested in use of temporary (or permanent) construction buildings after completion of construction.
    14.4 If construction buildings will be supplied by customer, determine whether customer will furnish lighting and plumbing.

15.0 Obstructions. This applies primarily when new work is an existing plant.
    15.1 Determine if any overhead electric power feeders are in area or near area. Obtain height and voltage.
    15.2 If guyed derrick is to be used check surrounding area for location of guy anchors.
    15.3 Check clearance of overhead piping runs for equipment delivery and also for 15.2.
    15.4 Check for existing underground electric and pipe lines and responsibility for removal if they interfere with new work.

16.0 Concrete. If job site is near city or metropolitan area, ready-mix concrete may be available. Check suppliers, prices and capacity. If no ready-mix concrete is available check for availability of washed sand and gravel and desirability of providing a bulk mixing plant at job site. Other basic materials used in building construction should also be checked for availability in area.

17.0 Excavation, Back-fill. Determine spill area for excavated materials. Determine availability of unwashed sand for back-fill.

18.0 Labor.
    18.1 Availability of skilled labor. Discuss with local contractors, plant operators, U.S. Employment Bureau.
    18.2 Organized Labor. Obtain names and addresses of all local business agents, determine plant union status and/or participation.
    18.3 Obtain schedule of craft rates, practices, pension and other agreements as folows:

	Contract Expiration Date	Basic Rate	Fringe Benefits	Total
Pipe fitter	____	____	____	____
Iron worker, structural	____	____	____	____
Iron worker, reinforcing steel	____	____	____	____
Electrician	____	____	____	____
Carpenter	____	____	____	____
Operating engineer	____	____	____	____
Boilermaker	____	____	____	____
Millwright	____	____	____	____
Bricklayer	____	____	____	____
Sheet metal	____	____	____	____
Insulator	____	____	____	____
Cement finisher	____	____	____	____
Painter brush	____	____	____	____
Painter spray	____	____	____	____
Painter highlevel	____	____	____	____
Truck driver	____	____	____	____
Winch truck operator	____	____	____	____
Hod carrier	____	____	____	____
Common labor—air tool	____	____	____	____
Common labor—pipe	____	____	____	____
Common labor	____	____	____	____

A SPECIAL REPORT

To Engineering-Contractors: A Checklist

Checklist of indirect labor costs.

18.31 Workmen's compensation.
18.32 Unemployment insurance.
18.33 Separation pay.
18.34 Vacation.
18.35 Transportation (labor).
18.36 Living allowance.
18.37 Benefits or other.
18.38 Guaranteed time and show-up.
18.39 Local Taxes if not included below.

18.4 Determine if local fabricating firms acceptable to erection labor.

18.5 Determine, if possible, productivity of craftsmen in area.

19.0 Insurance. Develop coverage required by customer. Liability for delivered materials or equipment unloaded from carrier.

20.0 Obtain copy of plant repair and maintenance safety rules.

20.1 Determine requirements for welding and burning.

20.2 Define and mark on plot plan area where restrictions must be observed or define precautions.

20.3 As noted above, if the work and other areas to be used by the contractor are isolated from the operating plant, usual safety precautions required by the plant owner may be simplified.

21.0 Invoice and Audit. Determine customer's requirements as to records (if contract is cost-plus), payroll copies, substantiation of contractor's invoices. If not specifically stated in contract determine preferred monthly billing date and determine copies of contractors and vendors' invoices necessary for substantiation of contractor's invoices.

22.0 Engineering Data.

22.10 Water. Determine available supply, source, water analysis, plant water treating method.

22.11 Steam or other power, in existing plant. Ascertain fuels now used.

22.12 Condensate recovery.

22.13 Cooling water. If new equipment to connect to existing service, check should be made as to capacity and type water.

22.14 Water wells. If water is to come from local stream or other, a survey may be required.

22.20 Soil Analysis. Customer should furnish soil load bearing data in pounds/sq. ft. at recommended depths. Determine acceptable type foundations, spread, pile, bored and reamed.

22.21 Ascertain water table depth.

22.22 Depth to rock or hard pan.

22.23 Frost line.

22.30 Elevation. See 5.0 above. Nearest local U.S. Geodetic datum should be noted. Note: if plant operator uses an arbitrary plane, the above need not be checked. Lowest grade in plant area will be arbitrarily established at 100.00 for construction and design purposes.

22.40 Determine customer's use of National Design Standards or any special codes in effect, or required by insurance. If not otherwise directed all designs will be in accordance with U.S. National Codes.

22.50 Obtain list of acceptable equipment suppliers (see 16.0).

Construction Survey—Foreign. All questions shown in domestic survey apply if the project is an addition to an existing plant. If the project is a grass-roots plant then the following may be used along with new items: 1., 2., 3., 4., 5.1, 5.2, 5.5, 7.

8.0 Material Procurement and Delivery.

8.1 Determine whether materials will be U.S. or foreign. If part foreign attempt to determine categories.

8.2 Determine serving marine carriers, and ocean freight.

8.3 Determine ocean port of entry.

8.4 Check tariff and custom laws, U.S. (export) and the country of erection.

8.5 Determine if U.S. restrictions as to materials or equipment exported to the country involved exist.

8.6 Explore handling facilities at port of entry.

8.7 If plant is inland determine carriers, methods of transportation, routes.

8.8 If customer will handle all ocean freight and shipping then parts of above may be deleted, however terms of contract should relieve contractor of any of these responsibilities and also should state that any hold-up in erection due to shipping being handled by others will accordingly extend completion date.

8.9 Obtain from customer, instructions as to documentation for (import) export and any packaging precautions necessary for export preparation, for instructions to vendors.

8.10 Check air-freight carriers.

9.0 Mail service. Establish proper mailing address to job site and determine whether packages of routine copies of blue-prints, other contract paper will be held in foreign customs. Check if any problems will arise over microfilm, that is shipments, air or marine, of microfilm for use in reproduction of construction drawings and other papers.

10.0 Check air mail and ocean mail. Times and costs.

11.0 Nearest city. Determine location of nearest city and possibilities of housing for expatriate personnel.

12.0 Weather. Same as domestic except for note about U.S. Weather Bureau.

13.0 Construction utilities, services. If a grass-roots plant these services must be supplied by contractor.

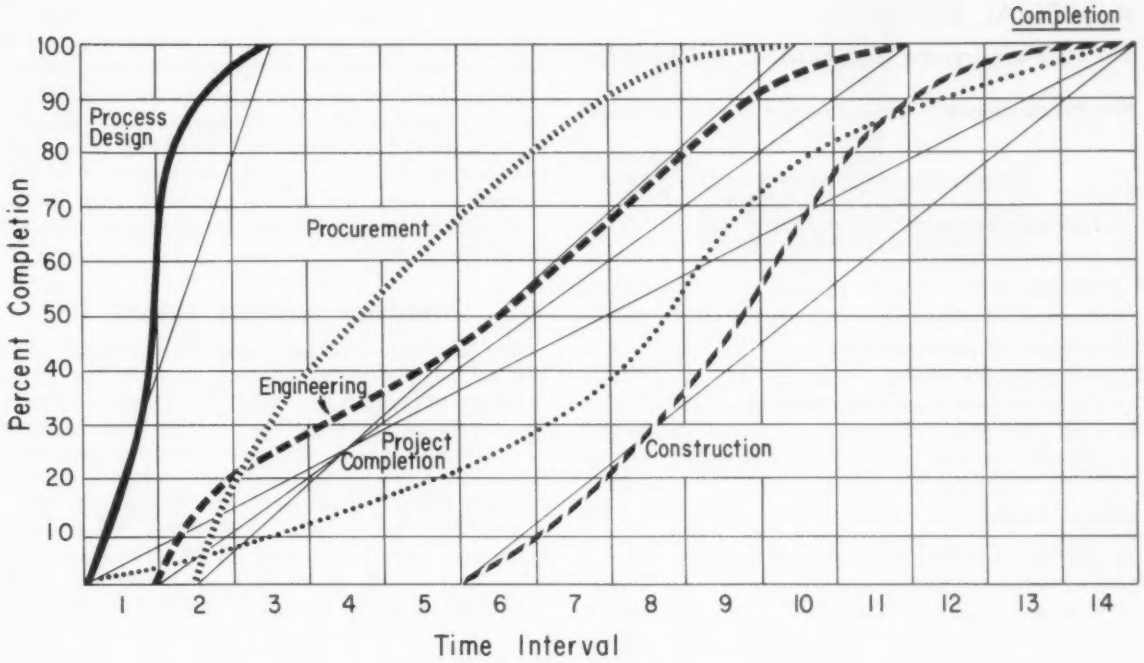


FIGURE 3—Project schedule curves.

14.0 Through 17.0 same as domestic.

18.0 Labor

18.1 Availability of skilled labor. In some foreign countries skilled labor is available, or depending on scope of contract, a training program may be required.

18.2 Obtain copies of all government regulations, practices applicable to the use of local personnel and also any requirements applicable to expatriates.

18.3 Same as domestic. Rates in currency of country. Indirects should be checked as they may be explicit or implied from 18.2.

18.4 Check if local fabricating firms exist.

18.5 Same as domestic. May be checked in 18.1.

19.0 Same as Domestic except international rules apply.

20.0 May be prepared by contractor for grass-roots plant.

21.0 and 22.0 Same as Domestic.

22.3 (Omit reference to U.S. Geodetic)

SCHEDULING FOR PROCESS PLANTS

The erection of a process plant follows the usual procedure for any kind of construction. Foundations and underground work must precede equipment erection. Before foundations can be constructed they must be designed and drawings must be prepared. Before the design can be completed, firm data (certified vendor prints) must be obtained from the manufacturer. This procedure must be followed for the design of foundations for equipment such as compressors, pumps etc. For equipment designed by the plant designers such as pressure vessels, structural steel and reinforced concrete structures, foundation design may start as soon as process sizing (capacity or volume) is complete and general size and weight established.

A most important part of any project is the preparation of a detailed schedule. Usually a contractor's proposal will include a general schedule showing the start and completion of engineering, procurement and construction.

Progress curves, percentage completion vs. time may be drawn for each of the three categories. Progress rate will vary to some extent for each type of project. Nearly all engineering-construction contractors have developed curves for certain types of projects. These curves may be varied according to the contract, installation, and equipment. While the curves will show desired and actual progress, the schedule is prepared in detail for each major item or kind of work with explicit dates for each step or part of the work.

The simplest procedure for beginning a schedule is the preparation of a bar chart (time vertically, in months or weeks) for each major or long delivery item. After obtaining manufacturer's delivery time (actual or estimated) the time intervals required before an order is placed and after the equipment is manufactured can be added. This will yield the total time required for an item.

The steps and intervals listed below show the time requirement for a major item such as a reciprocating, multi-stage compressor. The steps follow process engineering (indicated as eight weeks) which will have determined fluid composition, suction and discharge pressures and conditions, and general capacity requirement.

A SPECIAL REPORT

To Engineering-Contractors: A Checklist

Pre-Procurement (after completion of process design)

Step	Weeks	Approximate Week in Project
1. Specifications and inquiry	2	8
2. Release of inquiry	½	
3. Manufacturer's time for proposal	3	11
4. Analysis of proposals	2	13
5. Selection of manufacturer and/or approvals for purchase	2	15
6. Preparation of order and release. ½ (purchase order written)		18
Total	10 weeks	

Design Steps

7. Receipt of preliminary vendor prints	23
8. Start of foundation design	23
9. Completion of basic design	25
10. Start of drafting	25
11. Receipt of certified data from manufacturer	27
12. Completion of drafting and checking	30
13. Release of drawings for construction	30

Construction

14. Material procurement for foundation—start	23
15. Excavation and/or piling initial release—start	25
16. Form building—start	28
17. Receipt of anchor bolts and reinforcing	29
18. Receipt of drawings and release	30
19. Completion of forms	31
20. Pouring	31
21. Form removal	32
22. Equipment delivery arrival	40
23. Unloading	40
24. Machine setting	
25. Machine assembly	
26. Machine levelling	
27. Machine grouting	42
28. Final alignment	42
29. Run-in	43

There are obviously several gaps in actual work functions in the compressor schedule, used as an illustration. But the schedule shown is for a single element whereas for any project, many manufactured items in this category would be required. The time requirements for specification, inquiry, selection, and other steps for a small "built-together" type centrifugal pump, for instance, would be only a small percentage of the above. The differences in time of procurement and receipt of design data or steps (6) and (11) permit these parts of the plant design to proceed earlier or be delayed for best use of man power in the various engineering, technical, semi-technical, design and drafting phases.

In the early stages of any project the long delivery items are anticipated through experience and the project is scheduled to require all these items to be specified and/or designed as early as possible. The long intervals between the various important steps for the major items are used to complete requirements for the short delivery items.

PROJECT SCHEDULE CURVES

The preparation of the curves for a schedule chart will vary considerably for each project. The curves shown on Figure 3 are somewhat idealized. Process design may be completed upon receipt of the contract, in which case this curve would be unnecessary. Generally only a few persons are required in this phase of the work so that this curve is not of much use. There is usually a consultation requirement intermittently which may extend for several months. The engineering curve includes all equipment engineering as well as design and drafting. Generally the use of equipment engineers in the preparation of equipment specifications will be 30-40 percent finished when process engineering is complete; however as mentioned for the compressor, information from the manufacturers must be reviewed, as well as technical analysis of the equipment suppliers' proposals, so that consultation must be required on the major items, several months after the initial specifications and proposal analyses are complete. As can be seen, engineering continues into the eleventh interval. Actually, here also the project engineer or engineers must continue and many minor steps must be continued through completion.

Procurement curves will vary considerably with each project since they are usually based on dollars committed, rather than the consequences (effect on the work) of each major item of equipment.

Preparation of curves may be started, for instance with engineering, by accumulating the total manhours for each particular interval. The total estimated manhours will be 100 percent. Thus if the total estimated engineering manhours for the project were 40,000 and the accumulated manhours for the fifth interval, as required for the schedule, amount to 3200, the increase would be in the order of 8 percent. By using a method similar to the reverse of graphical integration, a series of points can be established. The same is obviously true for any of the curves. Generally the actual curves for a project are linear between the 25 and 75 percent completion points. The most difficult period of any project is in the first 30 percent of accomplishment, since it is during this period that much of the data from manufacturers is of a preliminary nature and for every project this is the period when all major equipment must be finalized so that procurement can act.

LITERATURE CITED

[1] McGarry, J. F. "A Checklist for Plant Layout," Petroleum Refiner, 37, No. 10, 109 (1958).

[2] McGarry, J. F. "How To Manage an Engineering Project," Petroleum Refiner, 38, No. 10, 149 (1959).

[3] Rose and Barrow. "Project Engineering of Process Plants," Wiley & Sons (1957).

What Project Status Reports Mean

The report does more than document job progress. It alerts management to corrective actions that should be taken and measures the competence of the project staff

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WHERE DO we stand? Are we on schedule? When will the Plant go on stream? What must be done to rectify situations which place the entire schedule in jeopardy? The answers to these and simular questions are of the utmost importance to management of construction contractors and operating companies alike. The correct representation of the status of a project and proper interpretations thereof constitute the basis for management's action in such diverse matters as manpower requirements, overtime, cash requirement forecasts, timely training of operating personnel, operating and production schedules, sales commitments, etc.

Any engineer or administrator who has ever been faced with the necessity of determining the exact status of a fairly complex project with which he had only a general familiarity, knows that wading through the voluminous schedules and detailed reports which exist in a variety of forms in most companies, is a time-consuming task which does not readily result in a proper interpretation. While such commonly used documents as Engineering, Drafting, Vendor Print, Procurement, Material Delivery and Construction Schedules are, in general, designed to serve specific purposes and do assist the engineers in the day-to-day conduct of their work, a busy management can hardly be expected to analyze all of this detail in order to maintain a current knowledge

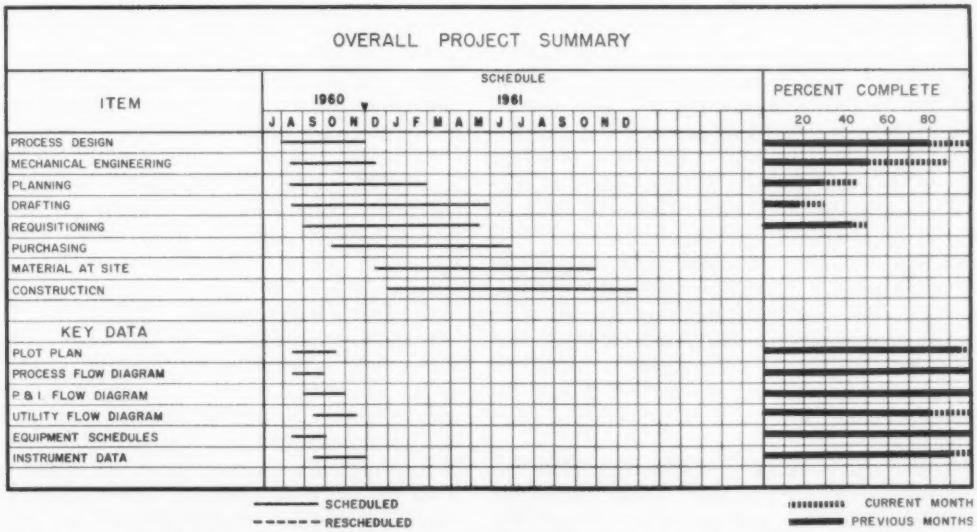


FIGURE 1—The Over-all Project Summary shows the status of the various phases of the project so they may be compared easily and quickly.

A SPECIAL REPORT

What Project Status Reports Mean

of the status of any given project under its administration.

Thus, it becomes the responsibility of the project engineering staff to reduce this volume of detail to the bare essentials without distorting in any manner the true status of the project in the form of a report. However, there is no hard and fast rule to determine these bare essentials. To some extent, this depends on the size and complexity of the project and the nature of the problems encountered. The status of major project components should always be reported but inclusion or exclusion of other matters which may or may not be of interest to management must be left to the judgement of the project manager or his equivalent. In most companies reasonably firm guide lines exist to assist the project manager in this respect. The resultant status report, usually issued monthly, must convey to managements of owners and contractors the proper representation of the project and indicate clearly those areas which may require management action.

Status Report. The properly executed status report is an indispensable document to management. In reality it does more than report the satisfactory or unsatisfactory status of a project. In its conclusions and recommendations it must alert management to any situations which may eventually affect the successful completion of the project so as to permit timely and appropriate action. All too often the status report is permitted to become a recording document after the time for corrective action has passed. In this respect the contents of the status report can and should be a direct measure of the competence of the project staff.

The status report must of necessity be brief and precise. As a minimum, it must contain the following vital elements in order to convey the status of the project:

- Representation of schedule
- Representation of performance
- Comments and conclusions relative to schedules and performance

The schedules included in the report should be depicted graphically. The classic S-curve is an excellent representation of a schedule in that the progress rate and other predictable conditions affecting the schedule may be plotted and identified at a glance. Periodic recording of progress against the schedule will also present a quickly-evaluated status. However, each S-curve should be presented with supporting data. It is recognized that a number of minor items may distort the status of a project in that an over-all completion percentage may be interpreted as being essentially on schedule while, in reality, serious problems exist. Statistical support for primary components is needed to alert attention to any particular item which may be seriously off schedule and aid in a proper evaluation of a specific phase.

The S-curve and statistics should be applied to the major phases of the project only. These phases are broadly accepted as Engineering, Procurement, Material Delivery and Construction. An over-all summary indicating the relationship of the major phases is also warranted and, in order to avoid repetition, should be depicted by means of the conventional bar chart. The over-all summary should also indicate progress and schedule for key data to present the status of what can be generally defined as the conceptual stage of a project. The report, of course, would not be complete without a written review and analysis corresponding to the major phases depicted by the curves, charts and statistics.

We will now take a closer look at the format and the meaning behind the data presented in this monthly status report. The following outline of a typical title and index sheet represents the sequence to which the report would be assembled.

Report No. ————————————
(type of Unit or Plant)
For
(Clients Name)
(Location)
INDEX

Progress Summary
Over-all Project Summary
Drafting Schedule and Status
Procurement Schedule and Status
Material Delivery Schedule and Status
Construction Schedule and Status

The Progress Summary contains the written body of the report and should be subheaded to correspond to the phases shown in the various schedules and status sheets. For the purposes of this article we have chosen the following typical subheadings which have been found adequate for most projects:

A. Engineering and Design
B. Procurement
C. Job Site Materials Status
D. Construction
E. Conclusion

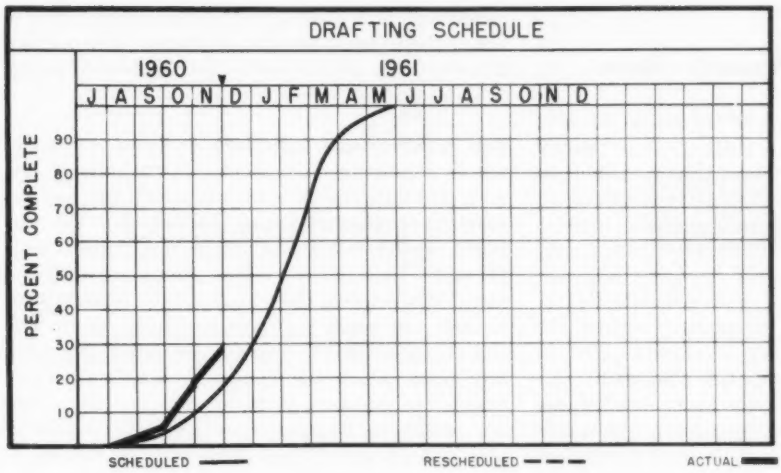
Under "A" a paragraph is included to describe the actual progress made during the month with regard to basic process and design data, flow diagrams, plot plans and critical equipment designs. In a separate paragraph progress in the production drafting and materials requisitioning departments is highlighted.

Procurement activities during the month are reviewed under subheading "B". Separate statements should be made with regard to commitment of major equipment and commodities. Critical items controlling the schedule should be given special attention.

Materials received at the job site are dealt with under subheading "C." Usually it is sufficient to report the general categories and value of materials received to date as a percentage of the total estimated value of equipment and material. Here again, however, special mention should be made of any critical items which have fallen behind schedule.

Under sub-heading "D" actual construction progress in the field is described by quantity installations such as the number of foundations poured, major pieces of equipment erected, feet of pipe installed, the number of instruments installed, etc. Mention should also be made of any special manpower problems which may exist, labor productivity and any other items which may have an effect upon final completion.

The final subheading of the Progress Summary is entitled "Conclusion" and contains an objective state-



DRAFTING STATUS

	GROUP					
	FOUNDATIONS	VESSELS	PIPING	STRUCTURAL	BUILDINGS	ELECTRICAL
NO. DWGS. REQUIRED	15	40	30	20	5	15
NO. ISSUED A.F.C.	2	30	0	0	0	0

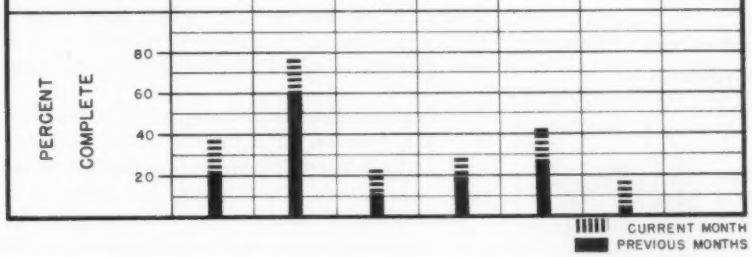


FIGURE 2—Schedule and Status pages give a quick visual reference of how you are doing.

ment as to the actual status of the project. In this section, the statements included in the categories of the major phases are correlated and conclusions made as to their affect on the over-all project. Also, appropriate recommendations are to be made to overcome any significant deviations from the schedule.

Additional subheadings may be used if other matters of importance to management are to be reported on. Examples of such matters are financing, contract negotiations, import licenses, relationships to other parties involved in the over-all project, etc.

Over-all Project Summary. The purpose of this summary is to present the schedule and status of the various phases so that they may be compared. Referring to Figure 1, under "Item," the primary components of the project are listed and the schedule for these items shown by means of bars to the right of the column in the grid system. An appropriate time scale for the project is to be applied. Similarly, Key Data are listed and scheduled since they are of general interest and constitute the primary effort on every project. Completion of these input documents implies that the various design groups are in possession of the data which enable them to attain peak rates of accomplishment. A typical listing of such Key Data is also shown in Figure 1.

The Over-all Project Summary is designed to acquaint the reader at a glance with the schedule of the principal phases of the project, to alert him to any revisions which may have been made and to inform him of the percent completion of the items as well as the progress made during the month. Readily distinguishable bars are to be used to define these representations.

Schedules and completions for engineering design data should be restricted to creative efforts. Routine and normal follow-up should not be reflected in the schedule or progress for these items so that the reporting will not be distorted by secondary and non-controlling considerations.

Schedule and Status Pages. The schedule and status data are designed to serve as a more detailed explanation of the Over-all Project Summary. Figure 2 indicates the typical format to be used. The scheduled S-curve is drawn on the upper half of these pages. Since

A SPECIAL REPORT

What Project Status Reports Mean

it is desirable to initiate issuance of the report as early as possible after the start of a project, it is usually necessary to prepare a set of approximate curves on the basis of general information. As more exact data are developed relative to engineering and drafting requirements, placement of orders, receipt of material and construction manpower, the curves are to be adjusted accordingly if required. Should a re-schedule be required, the new curve would be plotted against the original. The actual performance is plotted point to point monthly as a comparison to the schedule.

The status is represented on the lower half of the page below the schedule curves. The drafting status is divided into the main categories of drawing work such as foundations, vessels, piping, structures, buildings and electrical. Under each of these categories the number of drawings required is noted on one line and the number of drawings issued "Approved for Construction" tabulated on the line below. Percent completion for each of these categories is also shown by means of bars with a differentiation made as to the progress accomplished during the month. The calculation of the percent complete for the curve and bars is based on a manhour ratio. The number of drawings required and issued will, at a glance, portray the ultimate end toward which these man-hours are expended. The major design drawings only are counted and secondary drawings such as standards, isometrics, etc. are excluded.

The Procurement Schedule and performance is plotted as a function of dollar value committed. The Procurement status specifies the material quantities required, number requisitioned and number ordered for such items as towers, tanks, pumps, exchangers and compressors. This itemization is limited to major equipment. While this is only a part of the materials ordered, it does represent a significant dollar value and also reflects the status of outside engineering data and drawings upon which the design contractor's progress depends. For purposes of this report commodity items are not considered because of their variety and complexity and again because these items can be considered secondary and handled in a routine and predictable manner. Also, the delivery of such items is usually not controlling. Deviations from the normal routine of secondary items should be noted in the written discussion of this report.

The Job Site Material Schedule and performance is plotted in a similar manner as the Procurement Schedule which is as a function of dollars material delivered. The status section is divided into the same items as shown on the Procurement Schedule. In this instance, the major equipment shown is reported as to the number of items required and the number delivered.

The Construction Schedule and performance is plotted as a function of manpower. Since the erection of civil and mechanical items represents the primary field costs, select items of this nature are shown in the status report. However, mechanical erection (piping, electrical, instruments etc.) obviously cannot be started until the major equipment erection is complete and these items therefore appear again in this listing. As an example, the items listed for the Construction status are foundations (cubic yards), vessels (number), pumps and compressors (number), exchangers (number), pipe (feet) and steel (tons). The units required and units installed of each are reported.

The percent complete is recorded for the items in the status report for Procurement, Material, Delivery and Construction by bars similar to the Drafting status.

Since the nature of processing units may vary considerably, the listing of major or primary components will vary accordingly.

This report, professionally produced and printed on pages 8½ inches x 11 inches is a concise and easily-read reference document for any project. In addition to keeping management informed, the report also serves as a useful tool to engineering personnel who are primarily responsible for the basic data and facts included in the report and who must, therefore, be thoroughly familiar with all phases of a project under their jurisdiction. Equally important perhaps, an earnest effort is made to tell management what it wants to know in a standardized manner. It has been found in practice that this type of report can be produced to a great extent by an administrative staff after the basic data are established by the engineers in charge. ##

About the Authors

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Van Rassel

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Piersa

To Operating Companies: A Checklist for Project Engineers

Follow this guide and you can be surer that all details have been considered before you build

M. R. Noack
Mobil Oil Co., Beaumont, Texas

A PROJECT ENGINEER'S checklist has been developed from the viewpoint of the operating company that is about to go into a building contract. Covering every step from the beginning file system to the final contract, this guide will help you make sure that every important detail has been investigated before the contract is signed. It's especially adapted to the definitive estimates.

When Definitive Estimates? The definitive estimate approach to contracting is most often used when the owner is interested in obtaining the earliest possible completion of a project. In this case, he can release a contractor to proceed with design and construction along with preparation of a complete definitive estimate to establish the contract price later.[2,3]

Using this approach, it is very difficult for the owner to be sure that he really is "buying" an earlier completion and that he will pay a fair price for the work, since the force of competition is removed. For this reason, the owner's engineers must have considerable design and project experience in order to obtain a complete and accurate definitive estimate. The project engineer or group faces a myriad of details in developing firm de-

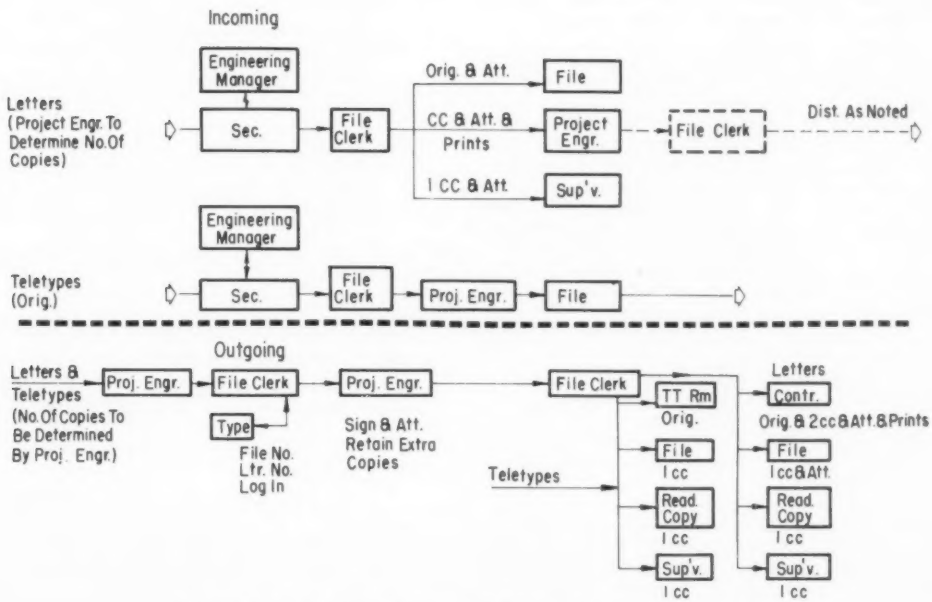

FIGURE 1—Routing of correspondence for a contract project.

A SPECIAL REPORT

To Operating Companies: a Checklist

tailed specifications and scope of work for the preparation of the definitive estimate and later analysis of the contractor's proposal. A checkoff list is most helpful to insure complete investigation of all details.

Assuming a contractor has been chosen, on the basis of inquiry proposals, to continue into the definitive estimate stage, the work must proceed quickly to maintain the completion schedule and project scope in complete detail must be settled. Various phases of this stage of the work generally proceed as follows:

1.0 **Develop a filing system and co-ordination procedure.**

1.01 A complete filing system for all correspondence, records, blueprints, contracts, specifications, etc., must be established in accordance with recommended practice. This file might have been started in the earlier phases of the project.

1.02 Figure 1 shows a typical correspondence flow sheet for incoming and outgoing material concerning the project. This is a recommended flow sheet, but may need revision and/or more detail for each specific project. A complete flow sheet should be prepared by the Project Engineer for each major project and furnished to the File Clerk for reference.

1.03 The table on pages 108 and 109 is a listing for distribution and action required for various attachments to correspondence which must be distributed within Company's organization. Although probably not all inclusive, it will serve as a guide in coordinating the work of the Project Engineer with all other involved personnel in the Company. Company as used in this checklist means the owner, operating company.

2.0 **Kick-off meeting. This meeting is held to discuss the organizations of the companies involved in the project and resolve procedure questions. To take full advantage of this meeting, it is usually wise to prepare an agenda for the meeting as well as obtain from the Contractor a list of items he might like to discuss. Below listed items are usually covered.**

2.01 Introductions—Personnel in both organizations are introduced and they are identified in the organizational setup for the project.

2.02 Job instructions. A manual is prepared by the Contractor and outlines procedures for Contractor's organization in handling correspondence, engineering, purchasing, drafting and accounting functions for the project. Job instructions for previous jobs furnish the best guide for the type information required to furnish to the Contractor for preparation of this book. This information should be listed in advance and reviewed at the kick-off meeting. Items that should especially be covered are:

2.021 Company addressee for general and contractual correspondence.

2.022 Correspondence and distribution.

2.023 Drawing approval and distribution.

2.024 Drawing numbering system.

2.025 Pipe Line numbering system and designation.

2.026 Equipment numbering system should be established.

2.027 Instrument numbering system.

2.03 Review of Company policies concerning construction meetings, normal working hours, security, cameras, safety (firewalls, personnel barriers, sewers) first aid, telephones, labor situation, parking (responsibility for maintenance), job access and approval of sub-contractors.

2.04 Discussion concerning utilities to be furnished by Company during construction, and layout of all shop, work and storage areas.

2.05 Arrangement should be made to have suitable office space provided by Contractor for Company inspectors. Requirements can be discussed in this meeting.

2.06 Discussion of job schedule. Scheduling of all phases of the project is very important, since, basically, the Company is trying to get an early completion. One of the main objectives of the Project Engineer is to see that schedules are established and followed.

3.0 **Establish a firm schedule for the Definitive Estimate Phase of the project which will pinpoint at least the following:**

3.01 Cut-off and completion date for process design.

3.02 Deadline for submitting equipment specifications for approval.

3.03 Completion date for firm piping and instrument diagrams.

3.04 Deadline for submitting bids for equipment selection.

3.05 Cut-off date for all transmittals to Contractor for inclusion in scope of work.

3.06 Completion and submittal date for definitive estimate and proposal.

3.07 Establish completion date for all special studies.

4.0 **Finalize process and utility information. Contractor should submit final process and utility flow diagrams with calculations for approval. All data established during the initial inquiry phase of the project should be reviewed and necessary changes or additions made. In addition, the following items should be considered.**

4.01 Does seasonal or adverse weather affect the process (i.e. hydrate formation in cold weather, unstable operation of precipitators in rain, effect of weather on long offsite transmission lines with regard to battery limit conditions, freezing, corrosion, etc.

4.02 Has residence time been considered in plot plan arrangement where it is critical from a process standpoint?

4.03 Are there any situations for low flow such as start-up, which would affect equipment selection or operation? (i.e. pressures above ratings due to near shut-off operation of pumps).

4.04 Are all parties concerned in agreement on utilities balance and battery limit or design conditions? Also, utility balance for all cases should be considered.

4.041 Normal

4.042 Design

4.043 Start-up

4.044 Spare pumps running

4.045 Decoking

4.046 Regeneration

4.047 Pressure drop through unit for cooling water should be specified.

5.0 **Finalize major equipment specifications, rating sheets and outline drawings. Listing below indicates items that usually must be covered in specifications other than Company General Specifications.**

5.01 Furnaces—Obtain information on the following:

5.011 Design

5.0111 Fuel gas requirements and burner design, (based on fuel gas characteristics).

5.0112 Header type, material, corrosion allowance, and inspection opening requirements.

5.0113 Heat absorption rate (maximum).

5.0114 Coke allowance

5.0115 Use of vertical heaters
5.0116 Locate process stream temperature thermowells
5.0117 Vendor to state volumetric heat release
5.0118 Is combination of services in single setting acceptable?
5.0119 Drawings required from vendor (Tube layout, outline drawing, performance curves, etc.)

5.012 Material and specifications
5.0121 Tube material and corrosion allowance
5.0122 Special heat treatment of tubes and headers
5.0123 Steam generation per Power Boiler Code, Section I
5.0124 Special inspection requirements (Magnetic particle, X-ray, etc.)
5.0125 Special pass arrangements
5.0126 Use of finned tubes
5.0127 Vendor to furnish drying out procedure as required.
5.0128 Specify that vendor shall include calculations for maximum tube wall temperature with proposal.
5.0129 Has type and extent of fireproofing been completely defined?
5.0130 Has fire protection water spray system been completely defined?

5.02 Pressure vessels
5.021 Nozzle check (Piping and instrument diagrams and general specifications)
5.022 Special linings (concrete, clad plate, strip liner)
5.023 Requirement for Company approval of vendor's drawings and welding procedures.
5.024 Special inspection requirements (Ultrasonic, Fluid Penetrant, X-ray, etc.)
5.025 Check physical arrangement of vessel closely for maintenance purposes, process residence time, and internals such as demisters and pump suction connections, tray details, inlet horns, etc.

5.03 Exchangers, specifications and rating sheet
5.031 Define type drawings required from vendor (construction details, material, etc.)
5.032 Requirements for testing, piping, and maintenance of exchangers with special internal features such as expansion joints, internal combination joints, etc.
5.033 If surface condensers are involved, have cleanliness factors been established?

5.04 Pumps and drives (specifications and rating sheets)
5.041 Mechanical seal requirements (approval required).
5.042 Auxiliary flushing system (gland or seal).
5.043 Check steam supply pressures for setting design conditions for inquiries.
5.044 Are space heaters and thermostats in motors required?
5.045 Auxiliary piping around each pump should be thoroughly reviewed with Operating and Maintenance Groups to provide start-up, warm-up, priming, steam-out, venting, steam blanketing of seals, etc., as required.

5.05 Compressors and drives (specifications and rating sheets).
5.051 Design
5.0511 Are any special factory tests required?
5.0512 Base plate or sole plate?
5.0513 Is balcony or grade arrangement desired?
5.0514 Are common seal and lube oil systems satisfactory?
5.0515 Should the main lube and seal oil pumps be steam turbine driven or motor driven?
5.0516 Obtain Mach number at inlet edge of vanes of each wheel of compressor.
5.0517 If operating noise above 80-90 decibels is possible, need for dampening of sound should be studied.
5.0518 Has adequate straight run of pipe been provided on suction inlet connection to insure equal distribution of gas in first stage inlet guide vanes?

5.052 Material and specifications.
5.0521 Review API Specifications 617.
5.0522 Special cleaning of lube piping (chemical cleaning preferred).
5.0523 Design and materials of lube oil and seal oil coolers.
5.0524 Design and materials of lube oil and seal oil pumps.
5.0525 All instrumentation, piping, motors, turbines, etc. should be in accordance with Company General Specifications unless specified otherwise in writing. Company should select all auxiliary equipment as described above.

5.053 Performance tests. Provide performance measuring instrumentation and sample connections as required to ascertain the following:
5.0531 Suction conditions:
5.05311 Gas Properties (analysis), Molecular Weight, Specific heat ratio Cp/Cv and compressibility factor (Z).
5.05312 Pressure
5.05313 Temperature
5.05314 Flow measurement (corrected for actual inlet conditions).
5.05315 Weight flow of oil injected if any.
5.0532 Discharge from First Section: (To Intercooler if applicable). Pressure and Temperature
5.0533 Inlet to Second Section: (From Intercooler if applicable).
5.05331 Pressure
5.05332 Temperature
5.05333 Weight flow and analysis of liquid knock-out in Intercooler.
5.05334 Suggest heat balance check on intercooler to double check 5.0533 above.
5.05335 Gas analysis to determine new molecular weight, Cp/Cv and (Z).
5.0534 Discharge from Compressor: Pressure and Temperature.
5.0535 Driver Requirements:
5.05351 Compressor speed
5.05352 Compressor horsepower (steam flow and steam conditions or electrical data).

5.06 Piping Specifications:
5.061 Design
5.0611 Classify piping for establishing corrosion allowances.
5.0612 Review requirements and type break flanges for alloy pipe.
5.0613 Review with Contractor method for calculating pipe size.
5.0614 Establish that portion of steam generation piping which must be installed as per ASME Power Boiler Code.
5.0615 What type sewer system is required for hazardous or toxic products?
5.0616 Steam-tracing requirements—Design and arrangement.

5.062 Materials and specifications
5.0621 Check for applications where electric resistance welded pipe and fittings may be required or more economical than seamless.
5.0622 Specify alloy piping inspection requirements (X-ray, Dye-penetrant, etc.)

5.0623 Fabrication, welding and testing procedures for alloy piping.

5.0624 Anchor lines at battery limits.

5.0625 Use of plug valves (Manufacturer, trim, etc.)

5.0626 Specification for flanges and wall thickness of booster educters shall be settled.

5.07 Building specifications and facilities. If company general specifications do not cover following provisions, these must be determined and cognizant people should be in agreement with final specifications.

5.071 Electrical classification and type lighting.

5.072 Facilities to be included in control room including space requirements behind panel, storeroom and space for lockers, sink and cabinet facilities and location, operators toilet and facilities, water coolers, etc. Contractor must be clearly advised as to what he is to supply.

5.073 Type and design of building including interior surface finish, type floor, roofing, etc., must be defined.

5.074 Type heating and cooling system and design requirements must be specified.

5.075 Is electrical switchgear adjoining control room, and if so, what type building covers this area? If switchgear area is open, it should be surrounded by fencing.

5.08 Miscellaneous items

5.081 Has scope of all special handling facilities such as cranes, gantrys, monorails, tube pull-

Who Gets Papers and Why . . .

CODE:
A — Approve (Writes letter.)
CA — Comment or approve
F — File
C — Comments on Contractor's items forwarded for information—approval not required
(† indicates no. of copies)
(*First line is approval issue, second line, subsequent revisions)

Description	No. of Copies Required	Process Engr.	Operating Div.	Mech. Div.	Safety Div.	ENGINEERING DEPARTMENT						
						Chief Engr.	Maint. Sect.	Const. Sect.	Util. Sect.	B. Prt. File	Eng. Dept. File	Project Engr.
1. Process Calculations	*2	CA-F	.....	.....	.....	.....	.....	.....	.....	.....	.....	A-F
and Material Balance	2	C-F	.....	.....	.....	.....	.....	.....	.....	F	.....	C
2. Job Instructions	2	.....	.....	.....	.....	A-F	.....	.....	.....	.....	.....	CA-F
	2	.....	.....	.....	.....	F	.....	F	.....	.....	.....	C-F
3. Process Flow Diagrams	4	CA-F	CA-F	.....	F	.....	.....	.....	.....	.....	.....	A-F(2)†
	8	C-F	C-F	.....	.....	F	F	F	.....	F	.....	C-F
4. Process P&ID's	7	CA-F	CA-F	CA-F	CA-F	.....	.....	.....	CA-F	.....	.....	A-F(2)
	9	C-F	C-F	C-F	C-F	.....	F	F	F	F	.....	C-F
5. Utility P&ID's	7	CA-F	CA-F	CA-F	CA-F	.....	.....	.....	CA-F	.....	.....	A-F(2)
	9	C-F	C-F	C-F	C-F	.....	F	F	C-F	F	.....	C-F
6. Electrical Line	4	.....	.....	CA-F	.....	.....	.....	.....	CA-F	.....	.....	A-F(2)
Drawings	5	.....	.....	C-F	.....	.....	.....	F	C-F	F	.....	C-F
7. Material Status	3	.....	.....	.....	.....	F	.....	F	.....	.....	F	C
8. Engineering Schedule	3	.....	.....	.....	.....	F	.....	F	.....	.....	F	C
9. Construction Schedule	3	.....	.....	.....	.....	F	.....	F	.....	.....	F	C
10. Contractor's Requisitions	5	.....	.....	.....	.....	.....	(when applicable)	.....	(when applicable)	.....	F	C-F
							C-F	F	C-F			
11. Contractor's Inquiries	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	F	C-F
12. Contractor's Bid	3	.....	.....	.....	.....	C	.....	.....	.....	.....	F	A-F
Tabulations with quotes												
13. Contractor's Purchase	5	.....	.....	.....	.....	.....	F(when app.)	F	F(when app.)	.....	F	F
14. Technical Data Books	4	F	F	.....	.....	.....	F	.....	.....	.....	F	
15. Equipment Data Books	3	.....	.....	F (Inst. Sect. only)	.....	.....	F	.....	.....	.....	F	
16. Operating and Instruction Manuals	7	.....	F	F(2)	.....	.....	F(2)	F	.....	F	.....	
17. Plot Plan and Elevation	7	CA-F	CA-F	CA-F	CA-F	CA	.....	.....	.....	.....	.....	A-F(2)
	10	C-F	C-F	C-F	C-F	C	F	F	F	F	F	C-F
18. Battery Limit Connections	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	A-F(2)
	3	.....	.....	.....	.....	.....	.....	F	.....	F	.....	C-F
19. Pipe-Line Lists-Insulation, Test Pressure, etc.	3	.....	.....	.....	.....	.....	.....	F	.....	F	.....	C-F
20. Pipe-Line Sizing Data (tabulation of calc.)	3	.....	.....	.....	.....	.....	.....	.....	.....	F	.....	C-F(2)
21. Foundations:												
a. Soil tests, Loads and Piling	4	.....	.....	.....	.....	C-F	.....	CA-F	.....	.....	F	A-F
b. Exceptions to	3	.....	.....	.....	.....	.....	.....	CA-F	.....	.....	F	A-F
Std. Specs.	3	.....	.....	.....	.....	.....	.....	C-F	.....	.....	F	C-F
c. Contr's. Spec.	3	.....	.....	.....	.....	.....	.....	CA-F	.....	.....	F	A-F
	3	.....	.....	.....	.....	.....	.....	C-F	.....	.....	F	C-F
d. Calculations	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	F	C-F
e. Drawings	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	A-F(2)
	3	.....	.....	.....	.....	.....	.....	C-F	.....	F	.....	C-F
22. Concrete Structures:												
a. Exceptions to	3	.....	.....	.....	.....	.....	.....	CA-F	.....	.....	F	A-F
Std. Specs.	3	.....	.....	.....	.....	.....	.....	C-F	.....	.....	F	C-F
b. Contr's. Spec.	3	.....	.....	.....	.....	.....	.....	CA-F	.....	.....	F	A-F
	3	.....	.....	.....	.....	.....	.....	C-F	.....	.....	F	C-F
c. Calculations	2	.....	.....	.....	.....	.....	.....	.....	.....	F	.....	C-F
d. Drawings	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	A-F(2)
	3	.....	.....	.....	.....	.....	.....	C-F	.....	F	.....	C-F
23. Buildings:												
a. Exceptions to	3	.....	.....	.....	.....	.....	.....	CA-F	.....	.....	F	A-F
Std. Specs.	3	.....	.....	.....	.....	.....	.....	C-F	.....	.....	F	C-F
b. Contractor's Specs.	3	.....	.....	.....	.....	.....	.....	CA-F	.....	.....	F	A-F
	3	.....	.....	.....	.....	.....	.....	C-F	.....	.....	F	C-F
c. Calculations	2	.....	(Arrangement dwgs. only)			.....	.....	.....	.....	.....	.....	.....
d. Drawings	4	.....	CA-F(2)	.....	.....	.....	.....	F	.....	F	.....	A-F(2)
	4	.....	F	.....	.....	.....	.....	F	.....	F	.....	C-F
24. Furnaces:												
a. Exceptions to	3	.....	.....	.....	.....	.....	CA-F	.....	.....	.....	F	A-F
Std. Specs.	3	.....	.....	.....	.....	.....	.....	F	.....	.....	F	C-F

ing and handling facilities, etc., been included and specified for the project?

5.082 Special safety equipment furnished by Contractor.

5.0821 Showers

5.0822 Tubs

5.0823 Eye Wash Stations

5.0824 Gage Glass Shields

5.0825 Are any safety structures required during construction such as firewalls, curtains, fences, etc.

5.083 Are all unit telephone systems and communication systems completely described and specified? Is an outside telephone with sound proof booth required for a mechanics telephone?

5.084 Has a list of safety equipment to be provided for the project been obtained?

5.085 From the standpoint of corrosion are there any special coatings required or is cathodic protection necessary on any equipment on-site or off-site? Do you wish to have Contractor install any corrosion coupons or samples?

5.086 Has miscellaneous equipment for new units to be provided by Company been reviewed and included in cost estimate?

5.087 If any special facilities for moving heavy equipment to jobsite through the refinery are required, Contractor should be responsible for survey and necessary provisions for handling material.

5.088 If project is a revamp, special attention shall be given to defining reuse of existing equipment, safety considerations, operation during construction and design responsibility.

6.0 **Final process piping and instrument diagrams (P&ID's). These are prepared by the Contractor**

Description	No. of Copies Required	ENGINEERING DEPARTMENT										
		Process Engr.	Operating Div.	Mech. Div.	Safety Div.	Chief Engr.	Maint. Sect.	Const. Sect.	Util. Sect.	B. Prt. File	Eng. Dept. File	Project Engr.
24. Furnaces:—Continued												
b. Contractor's Specs.	3						CA-F				F	C-F
	3							F			F	F
c. Vendor's Arrangement Drawings	5		C-F	C-F			CA-F					A-F(2)
	5		F				F	F		F		C-F
d. Vendor's Detail Drawings	3						CA-F					A-F(2)
	4						F	F		F		C-F
25. Pressure Vessels:												
a. Exceptions to Std. Specs.	3									F		A-F
	3						CA-F	F		F		C-F
d. Contractor's Specs.	3						CA-F			F		A-F
	3						F	F		F		C-F
	3		Vessel Proper only				F	F		F		C-F
c. Contractor's Dwgs.	4		/C-F				CA-F					A-F(2)
	4			F				F		F		C-F
d. Vendor's Drawings	3						CA-F					A-F(2)
	3							F		F		C-F
e. Calculations	2									F		C-F
26. Heat Exchange Equipment												
a. Exceptions to Std. Specs.	3						CA-F				F	A-F
	3							F			F	C-F
b. Contractor's Specs.	3						CA-F				F	A-F
	3							F			F	C-F
c. Vendor's Drawings	3						CA-F					A-F(2)
								F			F	C-F
27. Pumps, Compressors & Drives:												
a. Exceptions to Std. Specs.	3						CA-F				F	A-F
	3							F			F	C-F
b. Contractor's Specs.	3						CA-F				F	A-F
	3							F			F	C-F
c. Vendor's Drawings	3						CA-F					A-F(2)
	3							F		F		C-F
28. a. Exceptions to Std. Specs.	3			*as applicable			*CA-F		*CA-F		F	A-F
	3							F			F	C-F
b. Contractor's Spec.	3						*CA-F		*CA-F		F	A-F
	3							F			F	C-F
c. Contractor's Dwgs.	2			C-F								A-F(2)
	4			F				F		F		C-F
d. Vendor's Drawings	3							F		F		C-F
e. Calculations	2									F		C-F
f. Underground Piping Drawings	3			C-F								A-F(2)
	4			F				F		F		C-F
29. Structural Steel												
a. Exceptions to Std. Specs.	2										F	A-F
	3							F			F	C-F
b. Contractor's Specs.	2										F	A-F
	3							F			F	C-F
c. Calculations	2									F		C-F
d. Contractor's dwgs.	2											A-F(2)
	3							F		F		C-F
e. Vendor's Drawings	3							F		F		C-F
30. Electrical												
a. Exceptions to Std. Specs.	3								CA-F		F	A-F
	3							F			F	C-F
b. Contractor's Specs.	3								CA-F		F	A-F
	3							F			F	C-F
			(Underground elec. dwgs. only)									
c. Contractor's Dwgs.	4		/C-F						CA-F			A-F(2)
	5		F	F				F		F		C-F
d. Vendor's Drawings	3								CA-F			A-F(2)
	3							F		F		C-F
31. Instruments												
a. Exceptions to Std. Specs.	3								CA-F		F	A-F
	3							F			F	C-F
b. Contractor's Specs.	3								CA-F		F	A-F
	3							F			F	C-F
c. Contractor's Dwgs.	3								CA-F			A-F(2)
	4			F				F		F		C-F
d. Vendor's Drawings	3								CA-F			A-F(2)
	3							F		F		C-F
32. Insulation and Painting												
a. Exceptions to Std. Specs.	3						CA-F				F	A-F
	3							F			F	C-F
b. Contractor's Specs.	3						CA-F				F	A-F
	3							F			F	C-F
c. Contractor's Dwgs.	3						CA-F					A-F(2)
	3							F		F		C-F

and along with the plot plan must completely define the scope of the work. These require the most careful attention to details. Preliminary P&ID's be forwarded by the Contractor for comments prior to final approval.

6.01 For final approval, distribute copies of P&ID's in accordance with Company policy. Comments from various departments and sections should be collected and reviewed at a scheduled meeting prior to transmitting comments to Contractor with approval. (Note: This step may vary with different organizations).

6.02 The following items should be completely resolved and located at this meeting.

6.021 Systems

6.0211 Water heating systems required for turnaround and cleanup.

6.0212 Determine blowdown, relief or dropout systems (type system, manual or automatic, electric or hydraulic operated valves, etc.) to be included in scope of work.

6.0213 Purge systems (Nitrogen, inert gas, etc.)

6.0214 Decoking and regeneration systems.

6.0215 Chemical cleaning connections if required should be shown.

6.0216 Instrument purge.

6.0217 Process steam and steam purge connections.

6.022 Details

6.0221 Drop-out spools and swing elbows (for decoking, pump suction strainers, water heater connections, etc.)

6.0222 Sample coolers (location and type).

6.0223 Turnover blinds (location).

6.0224 Control valve actions must be clearly indicated on all P&ID's.

6.0225 Alternate feed points to a tower. Are all connections at right location?

6.0226 Indicate grouped instruments.

6.0227 Special shut-down requirements.

6.0228 Start-up lines and jumpovers.

6.03 Are all instruments for accounting purposes established and located? Accounting Department should agree with final basis. (There may be additional requirements for operating and control purposes on some of these instruments.)

6.04 Establish firmly that equipment which is to be spared.

6.05 Are all lines entering and leaving unit which might accumulate condensate properly provided with knock-out drums and pumps?

6.06 Typical hook-ups showing vents, drains, couplings, etc.—These should be forwarded to Contractor early in the project to incorporate on P&ID's.

6.061 At major equipment

6.0611 Water-cooled exchangers and condensers.

6.0612 Process exchangers

6.0613 Pumps

6.0614 Steam turbines

6.0615 Vessel drains—water filling—pumpout connections

6.0616 Fuel gas to heaters

6.0617 Steam-out and snuffing steam to furnaces

6.0618 Decoking at furnaces

6.062 Miscellaneous connections and arrangements

6.0621 Hot water heaters

6.0622 Level controllers

6.0623 Control valves

6.0624 Displacement meters

6.0625 Sample coolers and sample connections

6.0626 Utility stations

6.0627 Typical instrument loops

6.0628 Typical process steam connections

7.0 **Final utility piping and instrument diagrams (P&ID's). These are prepared by the Contractor after a utility balance has been obtained for the project.**

7.01 For final approval distribute copies of P&ID's in accordance with Company policy. Handle the same as Item 6.01.

7.02 The following items should be completely resolved and located.

7.021 All instruments for accounting purposes shall be located.

7.022 That piping which must be installed in accordance with Section I of ASME Boiler and Pressure Vessel Code should be clearly identified.

7.023 If unit incorporates waste heat steam generation system, entire system shall be studied closely to achieve automatic control, easy start-up, slug-free operation and adequate sizing of vessels and equipment. Is an emergency source for boiler feed water to be included? Also, if condensate return lines are installed to Power Plants it shall have an emergency dump connection to sewer at the unit.

7.03 Have the following auxiliary equipment and system requirements been included as required?

7.031 Auxiliary equipment

7.0311 Emergency instrument air compressor with dryer.

7.0312 Fire pump and fire fog system.

7.0313 Hydraulic oil equipment and system.

7.032 Systems

7.0321 Neutralizer and/or inhibitor systems required.

7.03211 Rates and storage capacities.

7.03212 Pumps, equipment and special material required.

7.03213 Special safety devices for handling chemicals.

7.03214 Blending required and materials required to accomplish.

7.0322 Inert gas purge

7.0323 Drinking water system, elevator, urinals and trash shute for tall structures.

7.0324 Welding outlets

7.0325 Turnaround facilities

7.0326 Oxygen and acetylene systems

7.0327 Emergency power source for instrumentation

8.0 **Tabulation of bids is required on all major equipment or engineered items. (By Contractor inside battery limits and by project engineer for offsites.)**

8.01 Bids shall be firm for delivery predetermined to an established date including escalation.

8.02 Contractor should obtain a minimum of three bids having satisfactory delivery date. Two copies of all bids and engineering data to be included with tabulation.

8.03 Tabulations shall be submitted by Contractor in ample time to obtain approval from Company so as to include firm bids in definitive estimate and proposal.

9.0 **Other drawings. Besides the flow diagrams and P&ID's there are certain other drawings which should be completed and approved in this phase of the project. These are:**

9.01 Contractors Drawings
- 9.011 Vessel—design and outline drawings.
- 9.012 Equipment layouts or studies—as required.
- 9.013 Electrical area classification.
- 0.014 Electrical single line drawings.
- 9.015 Paving
- 9.016 Underground piping and sewer layout.
- 9.017 Piping plot plan layout (for estimate purposes), and including fire fog system in some detail. All lines three inches and above should be indicated unless unit is predominately small piping, in which case minimum pipe size shall be changed.
- 9.018 Building and major structure sketches.
- 9.019 Graphic panel.

9.02 Final plot plan, indicating roadways, exchanger and furnace tube pulling areas, catalyst loading areas, mobile equipment access areas, turnaround trailer area, etc. Final plot plan should be developed from preliminary plot plans obtained early in the project. J. F. McGarry, in another article, presents a checklist for plant layout.[1] In addition to this list, the following items should be considered in developing the final plot plan.
- 9.021 Imagine a complete turnaround and discuss with Mechanical or Maintenance Department.
- 9.022 Consider access roads into unit.
- 9.023 How does cooling tower or other off-site facilities affect plot plan? Is prevailing wind a factor?
- 9.024 Location of control room. Get Operating Division and Safety Division opinion.
- 9.025 Are items which require close watch by operators near control room?
- 9.026 Will auxiliary control room be required?
- 9.027 Have safe distances been maintained between equipment?
- 9.028 Does arrangement of equipment conform to economical electrical classification?
- 9.029 Should there be provision for future expansion or integration of unit?
- 9.030 Are large utility consuming items located near entrance of utility lines to unit?
- 9.031 Should electrical switchgear be located in or near control room or in another area?
- 9.032 Has equipment layout provided for minimum runs of expensive alloy piping?
- 9.033 Allow for catalyst and chemical loading and unloading areas and facilities.
- 9.034 Locate turnaround trailers and equipment.

10.0 **Offsite requirements. Entire scope of off-site facilities must be clearly defined and estimated in order to determine total cost of project.**

10.01 A complete off-sites flow diagram should be prepared showing all charge and rundown lines, tanks, instrumentation, pumps, etc. Appropriate Departments shall review drawings to insure that facilities are all inclusive and completely operable for all types and conditions of operation.

10.02 A complete study or diagram of all utility requirements and off-site installations should be worked up. Appropriate Departments should be in agreement on these provisions.

10.03 Additional off-site requirements such as roads, piping, right of ways, cooling tower and auxiliary equipment, nitrogen or purge gas facilities, fire fighting equipment, fire water, service water, boiler feedwater, raw city water, drinking water lines, sewers, blowdown and flare equipment, turnaround toilets, etc., shall be included as required.

10.04 A detailed estimate of all the above facilities should be prepared and added to the Contractor's definitive estimate when submitted to determine total cost.

11.0 **Proposal and definitive estimate**

11.01 Project Engineer shall establish clearly the information required for comparison purposes and the date this information is required for review.

11.02 Meetings should be scheduled with the Contractor to answer questions and settle any differences and final revisions must be completed prior to date established under item 11.01.

12.0 **Contract**

12.01 Before contract is signed, it should be completely reviewed. The following items are particularly important.
- 12.011 Are all definitions clearly stated (i.e., operationally complete, initial operation, etc.)
- 12.012 Are the duties of Company complete and **correct?**
- 12.013 Are hydrostatic test procedures and acceptance of work paragraphs acceptable with Construction or Inspection Engineers?
- 12.014 Are **hydraulic, process** and **utility** guarantees covered as required?
- 12.015 Is warranty on unit clearly defined in terms of:
  - 12.0151 Period of time involved and responsibility of Contractor on unit?
  - 12.0152 Period of time involved and responsibility of equipment vendor under the contract?
- 12.016 Is extent of Contractor work clearly defined to establish when unit will be considered acceptable and operationally complete by the Company?
- 12.017 Has responsibility for run in of equipment been defined along with responsibility for furnishing materials such as flushing oil, lubricating oil, grease, packing, etc.?
- 12.018 Does Company require breakdown of unit costs for accounting purposes? If so, this should be included in the Contract.
- 12.019 Does Company require Contractor to completely wash out and make the unit ready for processing of hydrocarbons?

About the Author

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Noack

LITERATURE CITED

[1] McGarry, J. F., "A Checklist for Plant Layout," Petroleum Refiner, Volume 37, No. 10,109, October 1958.
[2] McGarry, J. F., "How to Manage an Engineering Project," Petroleum Refiner, Volume 38, No. 10,194, October 1959.
[3] Rase and Barrow, "Project Engineering of Process Plants," Wiley and Sons (1957).

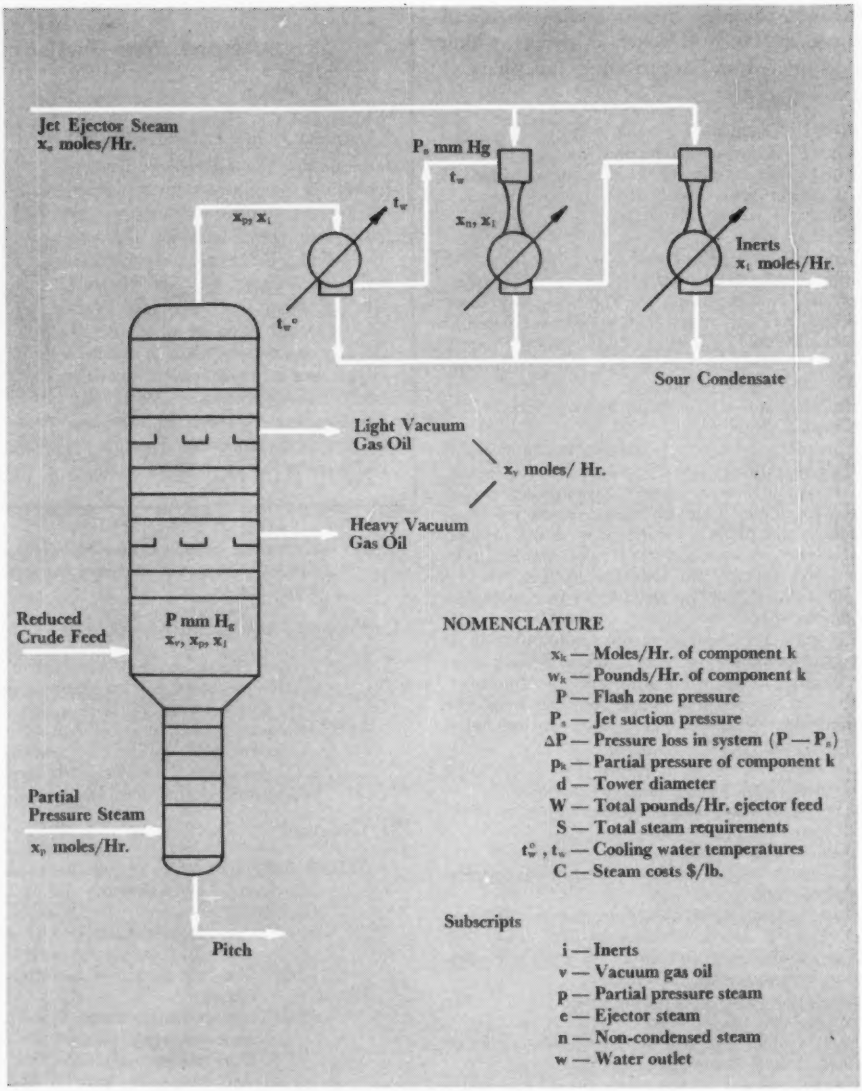

FIGURE 1—This is the type of vacuum distillation process discussed here. Notice the nomenclature on the right.

Find Optimum Vacuum Tower Pressure

Steam cost, cooling water cost and tower diameter are included in this equation for the most economical tower operating pressure

Gerald T. Westbrook*
University of Minnesota, Minneapolis

OPTIMUM VACUUM TOWER pressure can be set by finding the tower and suction pressure which gives a minimum steam requirement. Previous studies have used an approximation for the jet steam requirement and then solved the problem graphically.[7] It will be shown that such an assumption is justified by deriving an exact expression for the steam load, computing the optimum pressure and comparing this with the pressure found by the approximate method.

It is then possible, by using this assumption, to derive the following equation for the approximate optimum pressure by conventional differentiation:

$$P_s = p_w + \sqrt{K\, p_v\, p_w} \qquad (4)$$

where $K = 1.26 \left(\frac{C_e}{C_p}\right)\left(\frac{x_i}{x_v}\right)\left(\frac{w_e}{W}\right)$

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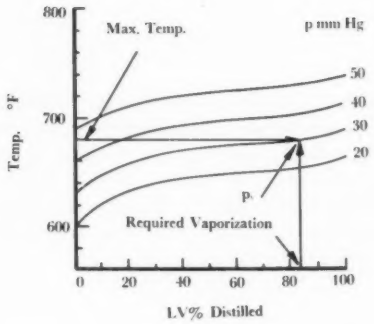

FIGURE 2—The required effective pressure P_v, in the flash zone can be found from a set of reduced crude flash curves such as these.

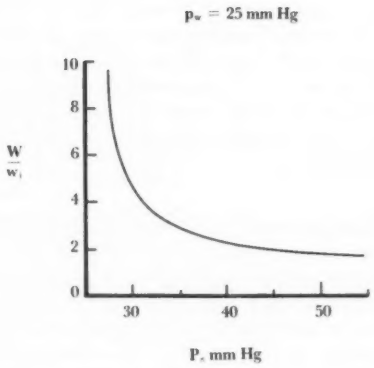

FIGURE 3—For a given design inerts and water vapor pressure would be fixed. Notice how an increase in pressure reduces the weight of ejected material and hence the ejector load.

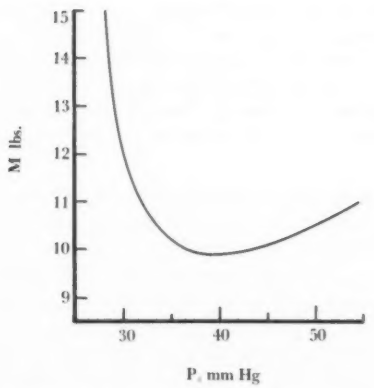

FIGURE 6—This plot, using the exact method, shows the optimum vacuum tower pressure to be about 41 mm Hg.

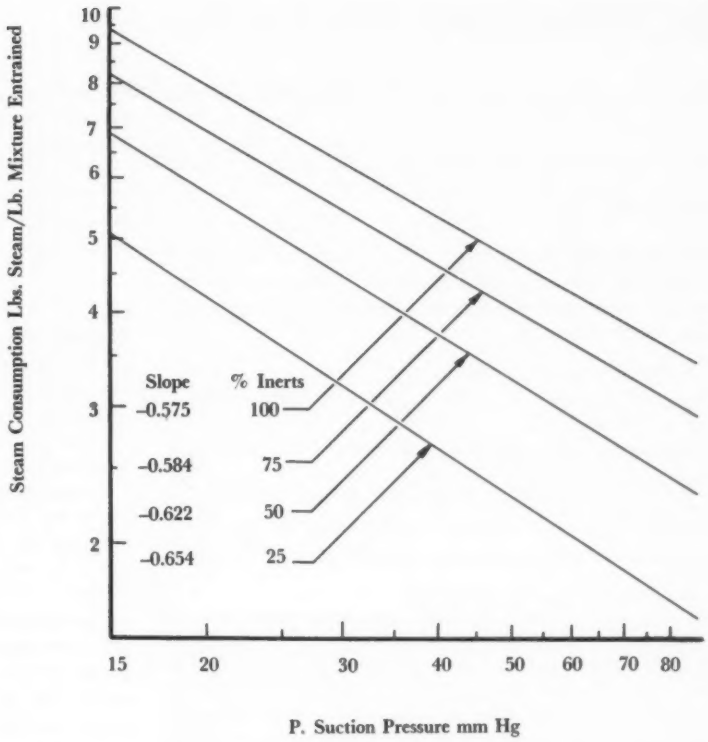

FIGURE 4—Notice how steam consumption by the ejectors varies directly with the weight of entrained material. These data are for 2 stage ejector, 100 psig steam and 85° F cooling water.

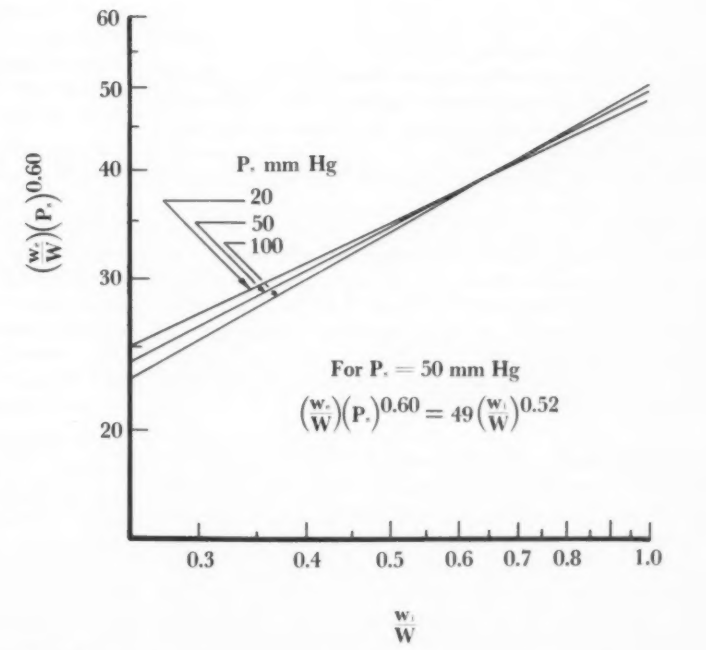

FIGURE 5—Pick off constants A and c for Equation (14) to calculate jet steam consumption for three valves of jet suction pressure, P_s.

Here some constant value for $\left(\frac{w_e}{W}\right)$ would be assumed.

This could be checked later when P_s, and $\left(\frac{w_i}{W}\right)$ has been found.

The Optimum Problem. In the vacuum distillation of a specified flow of a reduced crude oil feed, several factors will influence the capital investment and operating costs. Such items as:

- Flash zone temperature
- Tower pressure
- Percent vaporization of feed
- Physical properties of vacuum gas oil (VGO) product
- Level of non-condensable gases in the system
- Cooling water temperature

would all be of importance in a vacuum process design as illustrated in Figure 1. Fortunately, for a given design situation only the tower pressure would remain to be established. All the other factors would be fixed by experience, design practices, product demand and nature of the crude oil used.

Tower Diameter. Four quantities are affected by the level of the tower pressure. Initially, it may vary the tower diameter, since both the vapor flow rate and density will depend on it. When vapor loading controls the tower diameter, it is easy to show that:

$$\frac{d_2}{d_1} = \left(\frac{P_1}{P_2}\right)^{1/4} \quad (1)$$

Thus a 50 percent increase in the operating pressure would decrease the diameter by less than 10 percent. Because of this fact and because the liquid loading may determine the tower diameter at times, this factor generally has been ignored in previous optimization studies.

Jet Steam. The principal influence the tower pressure has on costs occurs with the amount of steam required for partial pressure effect and for the operation of the jet ejectors. The cost for this steam is by far the largest single operating cost for this process.[1] A reduction of 1,000 pounds per hour in steam requirements would mean an annual saving of $4,500, for 50 cents/1,000 pounds steam.

Stripping Steam. Partial pressure steam is needed to enable the required vaporization to occur at a temperature below the thermal cracking region. The jet steam, of course, is required to drive the vacuum producing equipment. Whereas the amount of partial pressure steam increases linearly with tower pressure, the jet steam required falls off rather rapidly. As a result the optimum pressure tends to approach the minimum pressure given by:

$$P_{min.} = p_w + \Delta P \quad (2)$$

where p_w is the vapor pressure of the cooling water in the ejection system.[2] ΔP represents the pressure loss between the flash zone and the inlet to the ejectors. It has been found more convenient to use the ejector suction pressure as the independent variable for this optimization. When needed, the tower pressure can be readily obtained from the equation:

$$P = P_s + \Delta P \quad (3)$$

Cooling Water. The final cost factor for this process is the cooling water requirements for the vacuum condensers. This will depend on the amount of partial pressure steam required, the amount of jet ejector steam used, and the temperature rise in the cooling water. This temperature rise might be small, e.g., 10° F, to avoid a temperature cross with the process fluid,[3] or it might cover the entire permissible range from the inlet temperature up to 120° F. In either case, the full range could be achieved, since the outlet water for the first method could be re-used in other coolers in the refinery. As a consequence, the water load will be relatively small, and since water costs are much cheaper than steam, this factor also is generally excluded from the optimization model. In locations of excessive water cost, this item certainly might be included.

Flash Zone Requirements—Partial Pressure Steam. In almost all petroleum refineries, steam is employed to lower the effective pressure at which the reduced crude is to be vaporized. Without this steam, the flash zone temperature required to give the desired degree of vaporization would generally be exhorbitant. The practice has been to specify some maximum value for this temperature based on past experience and the properties of the reduced crude used. The required effective pressure, p_v, in the flash zone could then be found by reference to a set of reduced crude flash curves as shown in Figure 2.

There will be three psuedo components present—vacuum gas oil, inerts and steam—in the vapor phase of the flash zone. The moles of vacuum gas oil can be estimated from the yield, °API, and molecular weight of the VGO. It should be noted that this VGO is usually a rather high boiling cut and as a result an accurate prediction of the molecular weight is difficult. It would be wise, therefore, to compute this factor cautiously using several methods as checks. The methods in Nelson,[4] Maxwell,[5] and an article by Winn,[6] could be used for this purpose.

The moles of inert gas is also a difficult quantity to estimate. Nelson[7] states that the total gas, exclusive of leaks in the system, ranges from 15-50 pounds per 1,000 barrels of feed stock. This includes air dissolved in steam generating water, air dissolved in the feed, a tail of low boiling material in the feed, and gases liberated from the feed via mild thermal cracking. In addition to this gas, Frumerman,[8] gives an estimate of the air leakage into a vacuum system as a function of system volume and pressure. These two references could be used to arrive at some reasonable design specification for x_i.

TABLE 1—Exact Steam Requirements

P_s	180 P_s	w_p	P_s—26.1	$\left[1+\frac{20.1}{P_s-26.1}\right]$	$\left[1+\frac{20.1}{P_s-26.1}\right]^{0.48}$	$P_s^{-.60}$	w_e	S
28	5040	2880	1.9	11.6	3.24	0.135	12420	15,300
30	5400	3240	3.9	6.15	2.39	0.130	8850	12,090
35	6300	4140	8.9	3.36	1.79	0.118	6010	10,150
40	7200	5040	13.9	2.45	1.54	0.109	4770	9,810
45	8100	5940	18.9	2.06	1.42	0.102	4110	10,050
50	9000	6840	23.9	1.84	1.34	0.096	3660	10,500
55	9900	7740	28.9	1.70	1.29	0.040	3300	11,040

Data from Figure 6.

The partial pressure steam required can now be estimated from the pressure ratio, mole ratio relationship. Thus

$$\frac{x_v}{x_v + x_i + x_p} = \frac{p_v}{P} \tag{5}$$

which yields

$$x_p = \left(\frac{x_v}{p_v}\right) P - (x_v + x_i) \tag{6}$$

or

$$x_p = \left(\frac{x_v}{p_v}\right) P_s + \left[\left(\frac{x_v}{p_v}\right) \Delta P - x_v - x_i\right] \tag{7}$$

Ejector Capacity Requirements. The amount of fluid to be evacuated by the jets consists of the inerts plus the non-condensed steam present at the ejector inlet. As before, the pressure ratio can be used to compute this water vapor, x_n.

$$\frac{x_n}{x_n + x_i} = \frac{p_w}{P_s} \tag{8}$$

Therefore

$$x_n = \frac{p_w x_i}{P_s - p_w} \tag{9}$$

Using a molecular weight of 29 $\frac{\text{lbs.}}{\text{lb. mole}}$ for the inert gas the total weight flow to be evacuated would be:

$$W = 29\, x_i + 18\, x_n \tag{10}$$

or

$$W = 29\, x_i \left[1 + \frac{0.62\, p_w}{P_s - p_w}\right] \tag{11}$$

Hence

$$\frac{W}{w_i} = 1 + \frac{0.62\, p_w}{P_s - p_w} \tag{12}$$

Frumerman[8] gives certain correction factors to be used to convert these components to a common dry air equivalent. At the prevailing temperature at the ejector inlet, only a correction factor for the steam molecular weight is required. This has a value of about 0.805. As a result equation (12) becomes

$$\frac{W}{w_i} = 1 + \frac{0.77\, p_w}{P_s - p_w} \qquad \frac{\text{lbs. dry air}}{\text{lbs. inerts}} \tag{13}$$

This equation illustrates the importance of both the suction pressure and the water vapor pressure on the amount of fluid to be evacuated. For a given design, w_i and p_w would be fixed. Thus the weight of ejected material would fall rapidly with a rise in pressure. This is illustrated in Figure 3 for a water vapor pressure of 25 mm Hg.

Ejector Driver Steam. Unfortunately this quantity is a function of several interrelated variables. This is determined primarily by the amount of fluid to be ejected, the ejector suction pressure, and the fraction of water vapor in the load. Secondary factors would be the pressure of the driving steam, and the cooling water temperature. Several writers[3,8,9] have presented graphical or tabular correlations to predict the jet steam requirements from these variables. A brief inspection of this data indicates the following form of equation to be applicable:

$$\frac{w_e}{W} = A\, (P_s)^{-b} \left(\frac{w_i}{W}\right)^c \tag{14}$$

Figure 4 is a replot of the data by Fondrk[3] on log log scale. These data compare quite favorably with that reported by Frumerman,[8] being only a fraction higher. Although the value of b, obtained for various values of $\frac{w_i}{W}$, was not constant, an average value of 0.60 should prove to be sufficient. The values for the constants A and c can be found from a plot of $\log \frac{w_e}{W} + 0.60 \log P_s$ against $\log \frac{w_i}{W}$. This has been done in Figure 5 for three values of P_s. The equation for a 50 mm Hg suction pressure was chosen as quite representative of the system. The constants obained from this line convert equation (14) to:

$$\frac{w_e}{W} = 49\, (P_s)^{-0.60} \left(\frac{w_i}{W}\right)^{0.52} \tag{15}$$

Total Steam Consumption and Operating Costs. Equations (7), (13) and (15) can now be used to compute the total steam consumption. The two different steam requirements would utilize different qualities of steam, with a possible resultant price distinction. For example, the jet driver steam would be around the 100

psig level, whereas the partial pressure steam might be superheated exhaust steam. Thus the total operating cost would take the form:

$$C = w_p C_p + w_e C_e \quad (15)$$

$$\text{or } C = 18\,C_p\left[\left(\frac{x_v}{p_v}\right)P_s + \left(\frac{x_v}{p_v}\right)\Delta P - (x_v + x_i)\right] + 1421\,x_i\,C_e\left[1 + \frac{0.77\,p_w}{P_s - p_w}\right]^{0.48}(P_s)^{-0.60} \quad (16)$$

If both prices were identical the total steam requirements could be used rather than cost. Equation (16) would then become:

$$S = 18\left[\left(\frac{x_v}{p_v}\right)P_s + \left(\frac{x_v}{p_v}\right)\Delta P - (x_v + x_i)\right] + 1421\,x_i\left[1 + \frac{0.77\,p_w}{P_s - p_w}\right]^{0.48}(P_s)^{-0.60} \quad (17)$$

Optimization Methods. Several techniques could be used to arrive at the optimum suction pressure. Thus, equation (16) or (17) might be solved by plotting, differentiated and equated to zero, or simplified and then differentiated. Without simplification, the second method would yield a highly non-linear, irrational polynominal in P_s, which itself would have to be solved graphically. This would be of little advantage over the first method. However, if the above equations were simplified by assuming a constant value for $\frac{w_e}{W}$, the differentiated equation could readily be solved for P_s. If desired this value of P_s could be used with equations (13) and (15) to check the assumed value of $\frac{w_e}{W}$, and if necessary recompute P_s. For this method equation (16) would now take the form:

$$C = \left[\frac{18C_p\,x_v}{p_v}\right]P_s + 18C_p\left[\frac{x_v\,\Delta P}{p_v} - x_v - x_i\right] + \frac{29C_e\,w_e}{W}\left[1 + \frac{0.77\,p_w}{P_s - p_w}\right]x_i \quad (18)$$

About the Author

Westbrook

Gerald T. Westbrook is a chemical engineer with Dow Chemical Co., Midland, Mich., working on special projects. Prior to joining Dow, Mr. Westbrook attended the University of Minnesota where he did graduate work in chemical engineering, economics and applied mathematics. Mr. Westbrook was with Imperial Oil Ltd. at Sarnia, Ont., doing process design and startup of units. He has a B.S. in Chemical Engineering from the University of Saskatchewan.

The necessary and sufficient conditions for a minimum are:

$$\frac{\partial C}{\partial P_s} = \frac{18C_p\,x_v}{p_v} - \frac{22.3\,x_i\,C_e\,w_e\,p_w}{(P_s - p_w)^2\,W} = 0 \quad (19)$$

$$\frac{\partial^2 C}{\partial P_s^2} = \frac{44.6\,x_i\,C_e\,w_e\,p_w}{(P_s - p_w)^3\,W} > 0 \quad (20)$$

The second condition is true for all $P_s > p_w$. The first condition will be satisfied if:

$$P_s = p_w + 1.12\sqrt{\left(\frac{C_e}{C_p}\right)\left(\frac{x_i}{x_v}\right)\left(\frac{w_e}{W}\right)p_v\,p_w} \quad (21)$$

Compare Exact vs Simplified. Assume the following data has been computed or specified:

- flash zone temperature—680° F
- cooling water temperature: in—70° F, out—80° F
- $x_v = 300$ m/H $p_v = 30$ mm Hg
- $x_i = 20$ m/H $p_w = 26.1$ mm Hg
- $C_p = C_e$ $\Delta P = 20$ mm Hg

1. **Exact Method**—With the above data equation (17) can be used in the form:

$$S = 180\,P_s - 2160 + 28{,}420\left[1 + \frac{20.1}{P_s - 26.1}\right]^{0.48}(P_s)^{-0.60} \quad (22)$$

This equation is plotted in Figure 6. The optimum pressure is seen to be about 41 mm Hg.

2. **Approximate Method**—For this example assume $\frac{w_e}{W} = 4.0$. Equation (21) would then become:

$$P_s = 26.1 + 1.12\sqrt{\left(\frac{4 \times 20}{300}\right) \times 30 \times 26.1} = 42.2 \text{ mm Hg.}$$

For this P_s, equation (13) would give: $\frac{w_i}{W} = 0.445$. From equation (15), or Figure 4 the new value for $\frac{w_e}{W} = 3.41$. A second value for P_s would thus be $P_s =$ 41 mm Hg.

As a conclusion it can be stated that the equation derived from the simplified method is very easy and quick to use and can give quite accurate results. On consideration of the accuracy for x_i and x_v, the approximate method should be sufficient for nearly all purposes.

LITERATURE CITED

[1] Nelson, W. L., *Oil G. J.*, 115 (Dec. 1, 1958).
[2] Nelson, W. L., *Oil G. J.*, 107 (Aug. 4, 1958).
[3] Fondrk, V. V., PETROLEUM REFINER, 37 12 104 (Dec. 1958).
[4] Nelson, W. L., *Petroleum Refinery Engineering*, 4th Ed. P—McGraw Hill Book Co., New York, N.Y. (1959).
[5] Maxwell, J. B., *Data Book on Hydrocarbons*, P-21, D. Van Nostrand Co. Inc., New York, N.Y., 1950.
[6] Winn, F. W., PETROLEUM REFINER, 36 2 158 (Feb. 1957).
[7] Nelson, W. L., *Oil G. J.*, 171 (May 14, 1956).
[8] Frumerman, R., *Chem. Eng.*, 196 (June 1956).
[9] Nelson, W. L., *Oil G. J.*, 93 (Dec. 8, 1958).

Now Use Gas Chromatography For Glycol Analysis

The four glycols of ethylene can be defined in solution singly or in mixture with good precision using the method proposed here. Suggestions are given for making your own chromatographic apparatus

D. F. Wisniewski and G. C. Stalker
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GLYCOL SOLUTIONS can be analyzed more accurately and in less time by gas chromatography than by many of the more conventional methods. This technique is useful not only for routine quality control but also for special trouble shooting situations. And the equipment needed is easily constructed, inexpensive, simple to use.

Gas chromatography is an analytical method which involves volatilizing a small amount of sample and passing it through a heated column packed with a nonvolatile liquid impregnated on a high-surface-area solid support. See Figure 1. The vaporized sample is assisted through the column by means of a carrier gas, usually helium, and the individual components of these samples are separated, and eluted at the end of the column, in order of their solubility in the liquid phase.

Detection of the vapors at the column exit is accomplished by various means, the most common being a thermal conductivity measurement.

One or more pairs of heated wire filaments are placed in a cell wired into a balanced bridge circuit and thermal conductivity differences between the sample vapors and the reference carrier gas are shown as potential differences, due to the resistance change, on a recording potentiometer.

SOME TYPICAL RESULTS

The selectivity of the gas chromatography method can be demonstrated by the results from some typical examples. Commercial grade ethylene glycol (EG), diethylene glycol (DEG) and triethylene glycol (TEG) were purified by distillation and various synthetic mixtures made.

Samples of various mixtures were injected into the column and the fractions were eluted and shown as separated peaks on the recording chart. Such typical results give precision of ± 2 percent of the amounts present and some of these are shown in Figures 2 through 9.

HOW TO CONSTRUCT THE APPARATUS

The final assembly is shown in Figure 10. The chromatographic column is wrapped around the heater block although the column is not shown in this diagram.

The cell and heater block is made from a 4-inch piece of 2-by-2-inch mild steel key stock. Two types of filaments have been used for the detector elements:

- Model engine glow plugs[3]
- Matched pair of tungsten filaments

When analysis of trace components is required, the higher resistance tungsten filaments are more satisfactory. The

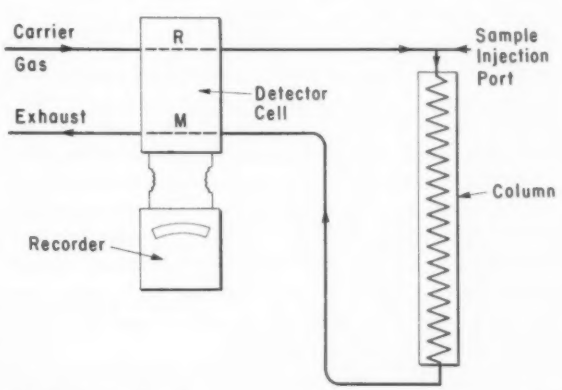

FIGURE 1—Gas chromatography equipment is easily constructed, inexpensive and simple to use.

glow plugs are the easier to mount and have sufficient sensitivity for analysis of most constituents.

How either of the two types or blocks is drilled to accommodate the filaments, heater, and ¼-inch tubing fittings is shown in Figure 11. Tubing connections are made to the block through ¼-inch tubing by ⅛-inch NPT 90-degree elbows inserted into the block. A 100-watt cartridge heater (½ inch by 2¼ inches) is held in place by a 8-32 allen screw.

The filaments, or plugs are mounted in the top of the cell and electrical connections are made, with brass screws through a 2-by-2-inch piece of ¼-inch insulation acting as a terminal board. Asbestos covered wire is then connected to these terminals with brass washers and nuts; eliminating any soldered connections.

Four 8-32 machine screws and nuts serve as legs to support the block assembly. Four 8-32 screws are also used for clamping the terminal board to the cell.

The sample injection port is a ¼-inch stainless steel tubing tee sealed at one end with a silicone rubber disc and connected as shown with a length of ¼-inch stainless steel tubing. The sample tee is air cooled to prolong the life of the rubber at elevated temperatures. The column is connected to this sample tee and the measuring inlet.

The column used was 6 feet x ¼ inch OD copper or stainless steel tube packed with a nonionic water-soluble surfactant (alkyl phenolethylene oxide type) impregnated on celite (30-60 mesh) at a ratio of 1 part solvent to 2 parts celite. (The solvent can contain volatile materials, but these will be eluted from the column in a short time at the operating temperature.) To fill the column ten grams of solvent was dissolved in 75 milliliters of acetone and poured into a glass pieplate. Twenty grams of diatomaceous earth was pourer into the mixture, shaken to distribute it evenly, and the acetone allowed to evaporate. The mixture was poured into the column, which was vibrated to insure uniformity, and the ends then plugged with glass wool.

This column combination has been used at temperatures of up to 275° C, and has proven to be the most universal column packing for a variety of samples. It shows the least amount of tailing for polar type compounds, such as glycols, alcohols and water. The column and three feet of entrance helium line, for preheat, are coiled around the cell block, which is wrapped with heavy aluminum foil. This unit is set into a four-liter stainless steel beaker or similar metal container, and expanded mica insulation poured around it to cover the block completely. Left protruding are the sample tee, helium inlet, two detector wires and thermocouple leads. The unit is then covered with another sheet of aluminum foil to contain the loose insulation. An assembly of this type has minimum air bath space, low heat loss and very good temperature control, which results in a very stable base line.

The cell and bath assembly is connected to the recorder through the zero control as shown on the wiring diagram.

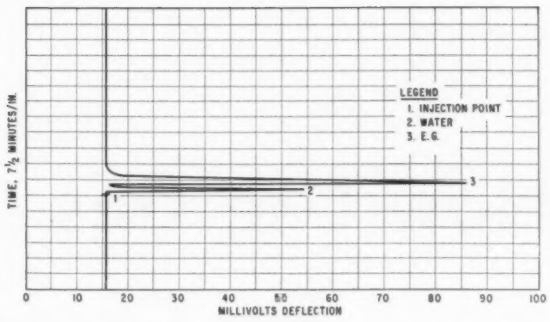

FIGURE 2—Ethylene Glycol and Water. Complete separation of these two components is obtained and peak measurement can be made successfully.

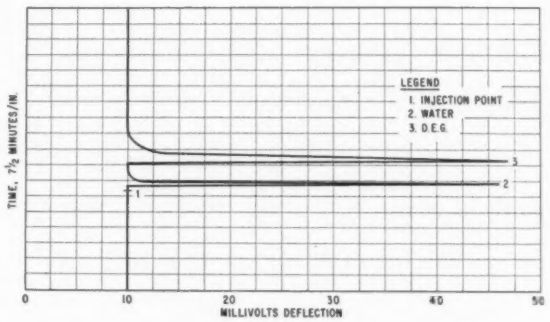

FIGURE 3—Diethylene Glycol and Water. Peak measurements can be correlated against known standards.

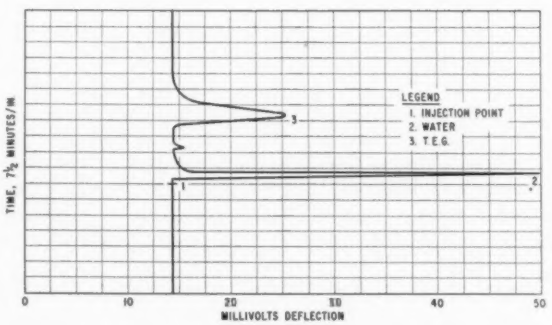

FIGURE 4—Triethylene Glycol and Water. The peak between TEG and water indicates some DEG is present even in distilled TEG (about 0.2 percent DEG in this case).

The recorder used was a 0-1 millivolt strip chart recording potentiometer equipped with an automatic range changing device for 10 and 100 millivolts. The range changer consists of four microswitches mounted at the rear of the recorder, two upscale and two downscale; two four-poled double throw latching relays, and a 1, 10 and 100 percent voltage divider using 0.1 percent precision resistors. The chart speed was 8 inches per hour and the pen speed was one second full scale. The temperature is controlled by adjusting the voltage on the heater with a variable auto-transformer and

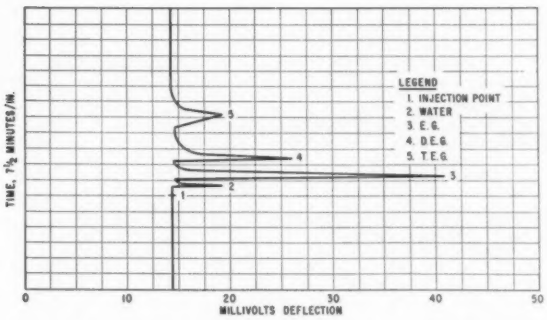

FIGURE 5—Equal Amounts of Mono-, Di-, and Triethylene Glycols (small amount of water). This resolution can be helpful when switching from one glycol to another in an operating process unit, or when one glycol is accidentally added to another.

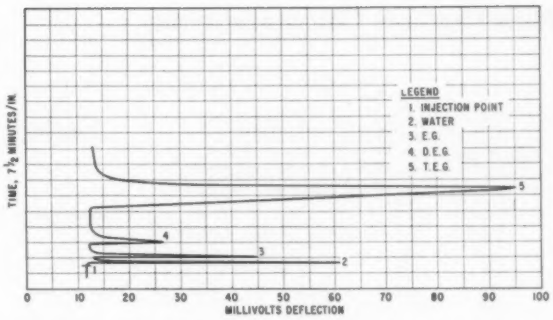

FIGURE 6—Low Concentrations of Mono- and Diethylene Glycols and A High Concentration of Triethylene Glycol. If high temperature decomposes TEG, the lower-molecular-weight glycols can be detected.

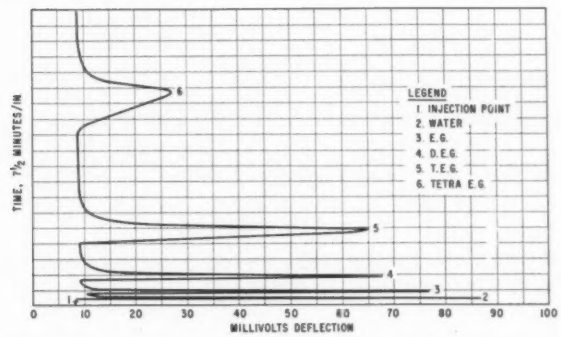

FIGURE 7—Mono-, Di-, Tri-, and Tetraethylene Glycols and Water. Note complete separation of all peaks, particularly between TEG and tetra-EG.

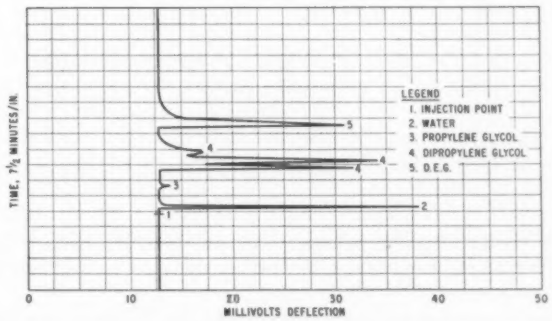

FIGURE 8—Mixture Normally Encountered in Udex Units. This analysis can be useful when a change from DEG to DPG is made. Note the three isomers of DPG are resolved.

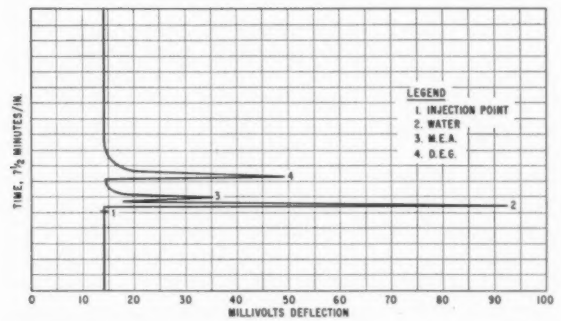

FIGURE 9—Mixture Normally Encountered in Glycol-Amine Units. Complete separation of all three components is accomplished.

read by means of an iron-constantan thermocouple wired to a 0-250° C pyrometer.

HOW TO USE THIS METHOD

The unit is allowed to come to operating temperature, usually overnight. Care must be taken not to exceed the desired temperature too greatly, as decomposition of the column may occur. The operating temperature will vary depending upon the separation desired—175°-200° C for water, monoethanolamine and EG mixtures; 200°-250° C for DEG to tetra-EG mixtures. It is best to keep a small amount of helium going through the column during the warmup period, about 10 cc. per minute being sufficient. The flow rate is raised to 50-60 cc. per minute in actual use.

When constant temperature is obtained and the recorder baseline is steady, a constant-size sample (15-20 microliters) is ejected with a microliter syringe. This syringe is able to deliver a 15-20 microliter liquid sample to a precision of ±1 percent, and handles viscous liquids such as tetraethylene glycol very nicely. Calibration is made using glycol standards of known concentrations, (weight percent) in the concentration range of the unknown. With water, EG or DEG, peak height is measured, since peaks are relatively thin. With TEG and tetra-EG peak area is utilized, because peaks are relatively broad compared to their height. Peak area can be calculated from the height times the width at ½ the height, or—better—with a polar planimeter. Alternate known and unknowns are run in triplicate, or at least in duplicate, to show the precision of the sample size and stability of the operating conditions.

Calibration Procedure. It is impractical to make a direct correlation of glycol content, with respect to peak measurements, over the entire range of concentrations.

Column age and fluctuations of flow, temperature and bridge voltage all combine to make a set calibra-

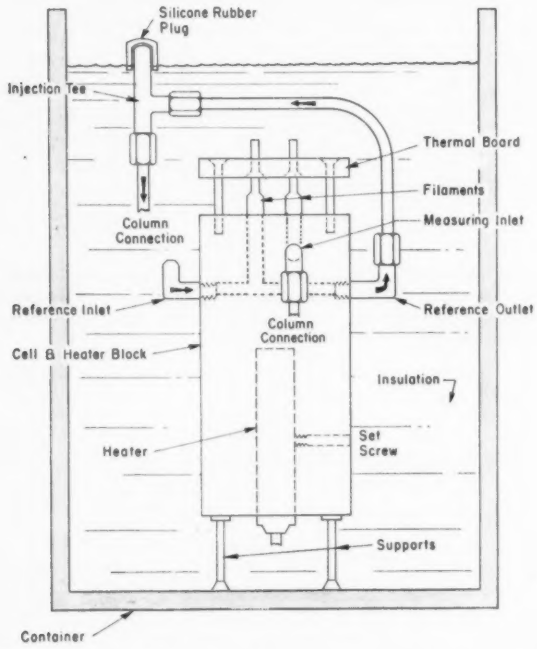

FIGURE 10—The column is omitted from this diagram to show cell and heater block details.

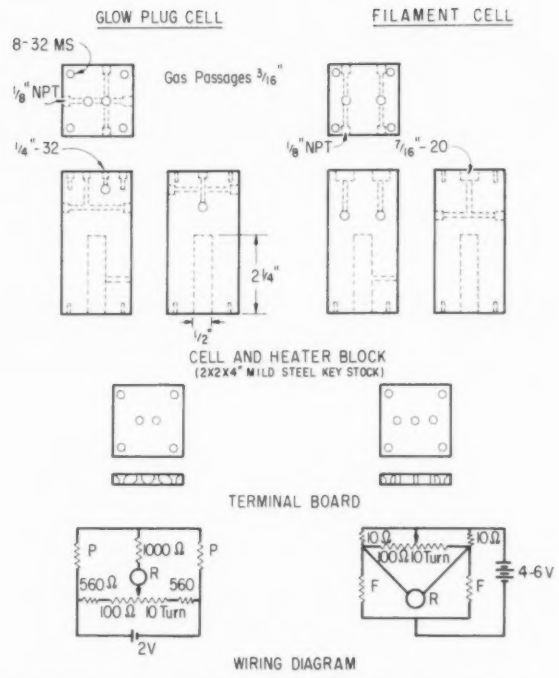

FIGURE 11—The cell block, terminal board and wiring for either type of apparatus are shown here.

tion factor uncertain. By using standards which are in the concentration range of the unknown, however, these variables are cancelled and a plot is made using concentration versus detector response for the concentrations usually encountered.

When determining an unknown sample, its glycol concentration is gauged from the plot and/or a known standard, in this range, ran and a direct proportion made from the peak values found. Final proof can be derived from a standard which has been made up to duplicate the unknown.

Interferences are not normally encountered, even in samples containing large amounts of hydrocarbons or sludges. Some difficulty, however, can occur with samples containing non-volatile inorganic compounds, which can concentrate at the sample inlet. This will cause the peaks to broaden tail and run together. The injection of small amounts of HCl will rejuvenate the column with subsequent increase in the sharpness of the peaks. A point will be reached, however, when this method of treatment fails. Physical plug-up of the column has occurred and a new column has to be made.

When high concentrations of these non-volatile inorganics are present at the sample end of the column, secondary elutions or false peaks will begin to appear. For instance, a sample of water can be injected and the water peak plus an EG peak will show. The EG peak is probably due to the actual release of EG which had been previously added and had formed a hydrate salt which was retained on the column. When water is added the hydrate salt is split and the glycol released. Evidence for hydrate formation is furnished by infra-red analysis and the synthetic production of the hydrate salt in the laboratory.

ACKNOWLEDGMENTS

The authors wish to thank R. L. Pearce and H. G. Scholten for their critical examination of the manuscript and many helpful suggestions.

REFERENCES

[1] Stone, K. G., Determination of Organic Compounds. McGraw-Hill, 1956.
[2] Keulemans, A. I. M., Gas Chromatography, Reinhold Publishing Corp., 1957.
[3] Felton, H. R., Proceedings, 1957, International Gas Chromatography Symposium, pp. 113-124.

About the Authors

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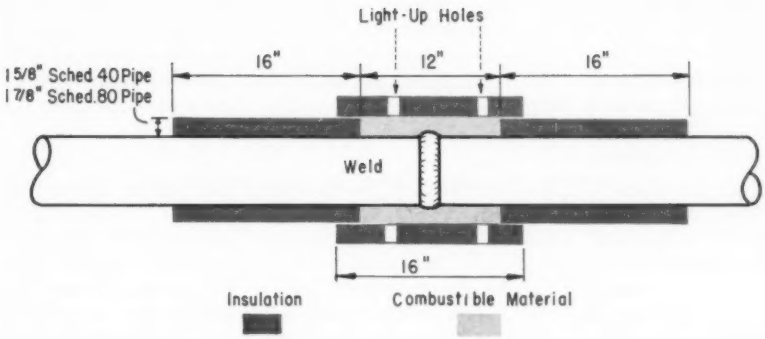

FIGURE 1—The kit contains premoulded combustible material and insulation. Put torch in light-up holes to ignite then fill holes with cement. Let it cook for a few hours then remove and check hardness.

Stress-Relieve Welds by Combustion

- **Saves time—place material on weld and torch light—no watching required**
- **Saves money if you do not air freight material to plant**
- **Adaptable to complicated stress-relieving jobs**

THIS NEW METHOD of stress-relieving field welds will remind you of the match-fired, self-vulcanizing tire patch. You simply wrap the material plus insulation around a weld to be stress-relieved, light it with a torch and walk away. The annealing temperature is automatically controlled by the burning process.

The combustible material consists primarily of aluminum powder, metal oxides, refractory materials and binders which are formed into half cylinders corresponding to the pipe size being stress-relieved.[1]

Insulation. Preformed insulation sections also come with the field stress-relieving kit. These are correctly sized to hold the precise time-temperature conditions around the weld area during the combustion period and to control the slow heat dissipation required to properly anneal the weldment.

The combustion and insulation sections are assembled on a welded pipe as shown in Figure 1. Insulating cement is used to fill the joints and cracks. The material is then ignited with an acetylene torch through two pairs of light-up holes located 180 degrees apart.

Is Postheating Required? When welds are made on air-hardenable chromium alloy steels, stresses are set up which may cause a brittle failure if the weldment is allowed to cool below a certain minimum temperature before it is stress-relieved. This possibility is greatest when the weldment temperature is allowed to cool below the transition temperature, that is, the temperature at which the weld area changes from a ductile to a brittle type. The temperature depends in part upon the condition of the metal. For example, it can be around 200° F for a 3 percent or higher chrome alloy weld in the non-stress-relieved condition.

If the alloy weld is to be stress-relieved upon immediate completion, a minimum preheat temperature of 350° F for 3 Cr. and higher or 300° F for less than 3 Cr. alloys should be maintained until heating for stress-relieving is begun. This is the normal procedure recommended by one of the major refiners today; however, in the case of the controlled combustion method, a modification is necessary. This is because the controlled combustion kits are designed to heat the particular weldment to annealing temperatures from a starting temperature of 80° F. If the higher Cr. alloy welds are allowed to cool to 80° F, there exists the danger of weld cracking; and if the alloy weld is at too high a preheat temperature, there is a danger of obtaining an excessively high annealing temperature. To minimize the hazard of either event, some refiners advise a starting temperature of 200-350° F for 3 Cr. or higher alloy and 80-350° F for 3 Cr. or less alloy welds previous to firing the controlled combustible material.

If it is impractical to stress-relieve 3 percent or higher chrome alloys immediately on completion of the welding, an alternate recommendation to postheating the weld has been made. A partial stress-relief treatment can be given the weld by holding it at 1,100° F for one-half hour per inch of thickness to reduce the intensity of the residual stresses and to restore some toughness to the weldment.

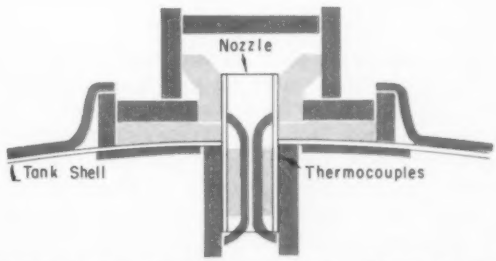

FIGURE 2—Complicated stress-relieving jobs such as this nozzle welded through a tank shell can be handled fairly easily by the combustion method.

Stress-Relieve Welds by Combustion . . .

How Does Preheating Affect The Maximum Annealing Temperature? The thermal efficiency of a controlled combustion process at a postheat temperature of 300° F is only about 50 percent of that at low temperatures. Therefore, instead of achieving a maximum temperature of 1,550 to 1,600° F as would be the case when starting from 80° F, the maximum temperature would be about 1,660 to 1,710° F when starting from a postheat temperature of 300° F.

The new Petroleum Refinery Piping Code ASA B31.3-1959 contains a section on Heat Treatment (331) which includes a subsection on Postheat Treatment (331.3) and a table giving the code recommendations for postheat treatment (Table 331.2.1). If you do not have an individual copy of this code available, look in the back of the 1960 REFINERY CATALOG for a reprint of the code and this section.

Costs. Savings can be had using the controlled burning method of stress-relieving over the induction heating process. For a comparison, look at the costs for stress-relieving the simplest kind of weld, a six inch, schedule 80 pipe-to-pipe weldment:

The cost of a controlled combustion kit for this job is $36 F.O.B. factory or distributor. Add about $9 for truck or rail shipment to your plant. The handling and installation costs would be about $2. Therefore, the total cost for the job would be approximately $46.

Using the induction heating method, the rental of the machine is about $24 ($6 per hour × 4 hours). The coil and insulating materials cost about $1.50. Setup costs are about $2. Operating costs for six hours at $4 per hour equal $24. Therefore the total cost of stress-relieving using the induction heating method would be about $51.50.

The estimated cost of induction heating is probably conservative. In actual practice a complete shift is often needed per weld, several crafts are involved and considerable work is done on an overtime basis. One plant has reported a stress-relieving cost of $200 for a single weld using the induction heating method.

Disadvantages of Controlled Combustion Stress-Relieving. A great many welds are made during routine maintenance operations which should be stress-relieved immediately. If stores doesn't have the combustion kits on hand for the particular weld and alloy being stress-relieved, the job could be completed by the electric resistance method while you are waiting for the kit to be delivered.

Because the combustible material and the insulating material is fragile, it must be packed in rather large crates and insulated from handling shock by such materials as rice hulls. A kit for stress-relieving a simple butt weld on a 6-inch pipe, for example, is packed in a crate about 4 feet x 4 feet x 3 feet deep. To maintain a reasonable supply of kits for normal field maintenance stress-relieving requires a fairly large storage area which must be protected from the weather. This also entails a considerable stores expense compared to the electric resistance method where welding machines are used on many other jobs. If you choose to let the manufacturer or distributor warehouse the kits, there may be too much delay in delivery time. Air freight delivery is possible but add $40 for freight costs instead of $9 in the example above. This may more than offset the savings gained.

Advantages of Controlled Combustion Stress-Relieving. When compared to the induction heating method of stress-relieving, the two main advantages of controlled combustion are cost and time savings. With the induction method, each weld requires its own machine and operator; and it normally requires about 6 to 8 hours total time per weld annealed. The controlled combustion kits can be placed on a number of welds and fired just before the close of a day. All the welds will be ready for uncovering the next morning. It is not necessary to watch the annealing operation once it is started because it is internally controlled by the combustion materials itself. Therefore, for a large number of welds, the controlled combustion method can be much more economical.

The combustible material requires a torch temperature of nearly 2,000° F for ignition. Therefore, it is reasonably safe to store the material and not create a fire hazard. The combustion material does have the characteristic of picking up moisture, but it is sealed in plastic bags when shipped from the factory and even if these are broken, heating in an oven for a few minutes will drive out any moisture pickup.

The combusion method is adaptable to complex stress-relieving jobs such as elbows, tees, valves, nozzles projecting into vessels (see Figure 2) and vessels that have large circumferential welds requiring stress-relief. In the case of large vessels, the combustible material is formed in pie shaped segments as shown in Figure 3, insulated, and ignited through light-up holes at the intersection of three triangles. This assures uniform burning which in turn assures uniform stress-relief. One company reported a quotation of $24,000 to stress-relieve a large vessel weldment by induction heating and $6,000 using the controlled combustion process. You don't need a crystal ball to figure out which method was used.

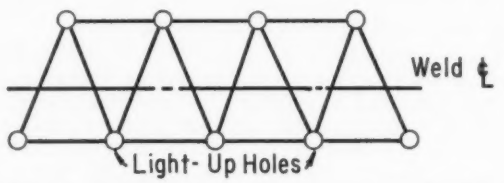

FIGURE 3—Large circumferential pressure vessel welds can be stress-relieved by using pie shaped segments of combustible material plus appropriate insulation. Lighting the material at the triangle intersections assures even burning and annealing.

For many field stress-relieving jobs, the self-contained combustion method has many advantages. It seems this is especially true when you have a large number of welds to stress-relieve at the same time or if you have a complex stress-relieving job.

LITERATURE CITED

[1] Sheely, M. F. & Lacey, B. L. "Postheat Treating Weldments With An Exothermic Material," *The Welding Journal*, Dec. 1958.

Use these charts for . . .

Enthalpy of Petroleum Fractions

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UNLIKE PURE chemical compounds, heavy petroleum fractions are defined as materials having a given boiling range, average boiling point and average molecular weight. Consequently, it is difficult to define rigorously specific properties, including enthalpy for these complex mixtures. The petroleum industry has generally adopted the use of "pseudo" compounds to characterize petroleum fractions. The "pseudo" concept of defining the properties of complex mixtures is based on the assumption that these mixtures will, within limits of course, behave as pure compounds of similar properties at the same reduced conditions.

Various charts and graphs have been developed providing basic enthalpy-temperature correlations for petroleum fractions; such parameters as mean average boiling point, or density in degrees API are commonly used.[1, 2] Additionally, graphs have been published for pressure corrections to the basic enthalpy data. Thus historically, the procedure for obtaining enthalpy data has been one of numerous steps usually involving the selection of an appropriate chart, and the making of one or more corrections to the basic data.

The enthalpy chart published by C. R. Bauer and J. F. Middleton in PETROLEUM REFINER[1] correlates the enthalpy of vapor and liquid petroleum fractions as a function of temperature and density in degrees API. Separate graphs for characterization factor and pressure corrections are provided on the same chart. Although this correlation provides reliable enthalpy data for most applications, the authors indicate that the reliability decreases markedly in the critical region. The critical region, however, is not indicated on their chart.

The critical region is however, defined clearly in J. B. Maxwell's[2] series of "dome" charts for the enthalpy of petroleum fractions. Separate charts are shown for petroleum fractions of various mean average boiling points, generally in 100-degree increments, and each of these is represented at characterization factors of 11.0 and 12.0. Saturated vapor and liquid "domes" are drawn for each fraction, showing the pseudocritical point where the latent heat of vaporization falls to zero. The pictorial nature of these "dome" charts eliminates some of the potential errors in application of the Bauer-Middleton correlation. However, in spite of the large number of charts, double interpolation is often required.

New Method of Presenting the Data. This procedure incorporates the advantages of both the aforementioned publications and eliminates most of the disadvantages. Figure 3 is an enthalpy-temperature correlation for various API petroleum fractions at a characterization factor of 11.8. Similar charts for characterization factors of 10.0, 11.0 and 12.5 (Figures 1, 2, and 4) are available along with Figure 3 in large size and color. (See the notice on this page.) Enthalpy determinations for characterization factors between these values may be obtained by linear interpolation, but for most purposes, the nearest chart value may be used.

The enthalpy of vapor is presented at zero absolute pressure. For most conditions, the zero-pressure data can be used for pressures up to about 50 psia before corrections become significant. A pressure correction run-around chart is provided for pressures between 50 and 1,000 psia. The liquid lines represent enthalpy of saturated liquid with the low temperature range (0-200° F) magnified on each chart.

The "domes" reflect the enthalpy of saturated vapor between the mean average boiling point and pseudo-

Convenient charts are available to determine the enthalpy of petroleum fractions as a function of temperature, density, composition and pressure. The basic data are unchanged from earlier publications. However, pressure corrections for the enthalpy of petroleum fraction vapors have been revised based on the Lydersen, Greenkorn and Hougen[3] correlation. The incorporation of pseudocritical properties and phase relationships in four basic charts promotes clarity and ease of use while reducing potential errors inherent in earlier methods of presentation. Of the four basic enthalpy-temperature charts developed, Figures 1 through 4, only Figure 3 (UOP "K" = 11.8) is presented here. A reprint of this article, including Figures 1 through 4 in a three-color arrangement, can be purchased for 75 cents from Reprint Department, PETROLEUM REFINER, P. O. Box 2608, Houston 1, Texas. Please send 75 cents with your order. Alternately, circle E27 on the Readers' Service Card; you will be billed with the delivered reprint.

critical point of the material, and saturated liquid near the pseudocritical point. The saturated vapor-liquid enthalpy domes around the pseudocritical point represents an area of great uncertainty. The estimation of latent heats in the critical region by the pseudo compound approach is questionable because of the difference in critical behavior between mixtures and pure components. It is possible for an actual fraction to have a latent heat where a correlation based on pseudo properties would indicate no latent heat was possible. For retrograde systems the confused shape of the vapor-liquid dome makes latent heat estimation even more difficult. These disadvantages are minimized by using the charts only for narrow boiling fractions, i.e., boiling ranges of less than 200° F.

The "domes" are convenient for estimating latent heats of vaporization directly. For this condition no pressure corrections are required since these graphs represent saturated vapor and liquid conditions. The "domes" also give a visual picture of the phase condition of a given petroleum fraction at certain operating conditions in realtion to the pseudocritical point of the material.

The dotted-line extension of the liquid enthalpy lines near and above the critical points represent an estimate of the enthalpy of the material in solution in this region.

The enthalpy charts presented here were adapted and developed primarily from data presented by C. R. Bauer and J. F. Middleton[1] and Lydersen, Greenkorn and Hougen.[3] The enthalpy of vapor at zero absolute pressure and liquid at one atmosphere is taken directly from the Bauer-Middleton data except that the basis is changed from liquid at 0° F to liquid at —200° F. The zero-pressure vapor enthalpies reproduce the experimental data within about ±5 Btu's per pound.

The saturated vapor-liquid "domes" are calculated in part from the data of Lydersen, Greenkorn and Hougen[3] using the Smith & Watson[6] correlation to compute the pseudocritical conditions. The enthalpy of saturated vapor is calculated as a deviation from the enthalpy of vapor at zero pressure. The saturated vapor line is drawn tangent to the zero-pressure vapor line at the mean average boiling point of each fraction. The saturated liquid portion of the dome is smoothed around the critical point and tangent to the basic liquid line. Resulting heats of vaporization ($H_{sat\ vap} - H_{sat\ liq}$) are consistent with the empirical relation:[4]

$$\frac{\lambda}{\lambda_1} = \left(\frac{1 - T_r}{1 - T_{r_1}}\right)^{0.38}$$

where

λ = Heat of vaporization at temperature t, Btu/lb.
λ_1 = Heat of vaporization at mean average boiling point, Btu/lb.
T_r = Reduced temperature at temperature t.
T_{r_1} = Reduced temperature at mean average boiling point.

It is possible to calculate points for the enthalpy of saturated liquid from the data of Lydersen et al.[3] However. because of an apparent inconsistency in heats of vaporization, these points are elevated considerably above the basic liquid enthalpy data established from the Bauer-Middleton[1] chart. Since the basic data of Bauer-Middleton[1] compare favorably with the data of Maxwell,[2] and since the heats of vaporization calculated here compare favorably with Watson's[4] empirical relation, it is felt that the smoothing of the saturated liquid line is justified.

The form of the pressure correction chart for the enthalpy of vapor is adapted from the Bauer-Middleton[1] presentation. However, the characterization factor parameter has been eliminated by using four separate enthalpy charts. Additionally, the pressure corrections have been modified in accordance with the data of Lydersen et al.[3] The pressure correction run-around chart is reliable except within the critical region (P_r between 0.8 and 1.2) where the deviations from calculated corrections may be as high as 15 Btu's per pound. For more accurate corrections in this range, and at pressures greater than 1,000 psia, reference is made to Figures 6 and 7 which will be discussed later.

Two examples are presented on Figure 3 to show how enthalpies and heats of vaporization can be estimated. The example shown below illustrates an interpolation method:

Example 1—Problem: Estimate the latent heat of vaporization of a 44° API oil at 695° F and K = 11.8.

Solution: Looking at Figure 3, it is obvious that the latent heat cannot be directly determined. The following procedure is suggested:

1. Estimate the pseudo-critical temperature of this stock from Figure 6.

$$T_c = 1190° R = 730° F.$$

2. Calculate the difference between the critical temperature and the temperature in question.

$$T_c - T = 730 - 695 = 35° F.$$

3. Estimate the latent heat of vaporization of 40° and 50° API oils from Figure 3 at temperatures 35° F below their respective critical temperatures.

40° API: $T = T_c - 35 = 795 - 35 = 760°$ F.
$\lambda = 605 - 561 = 44$ Btu/lb.
50° API: $T = T_c - 35 = 650 - 35 = 615°$ F.
$\lambda = 516 - 461 = 55$ Btu/lb.

4. Interpolate these results for a 44° API oil.

	40° API	50° API	44° API
λ	44	55	48 Btu/lb.

Pressure Correction for Enthalpy of Liquid Petroleum Fractions. Figure 5 presents a pressure correction for the enthalpy of liquid petroleum fractions. These corrections are almost negligible below pressures of 1,000 psia; however, they are provided here for work requiring a high degree of reliability. The chart was developed from the data of Holcomb and Brown.[5]

Pressure Corrections—Reduced Property Correlation. Figures 6 and 7 are two charts that can be used to establish accurate pressure corrections to the enthalpy of petroleum fraction vapors at zero pressure. These two charts should be used when operating pressures are greater than 1,000 psia, and also when the reduced pressure is between 0.8 and 1.2.

Figure 6 presents the pseudo-critical temperature and pressure of various petroleum fractions as a function of characterization factor and API gravity, based on the Smith and Watson correlation.[6] The pseudocritical tem-

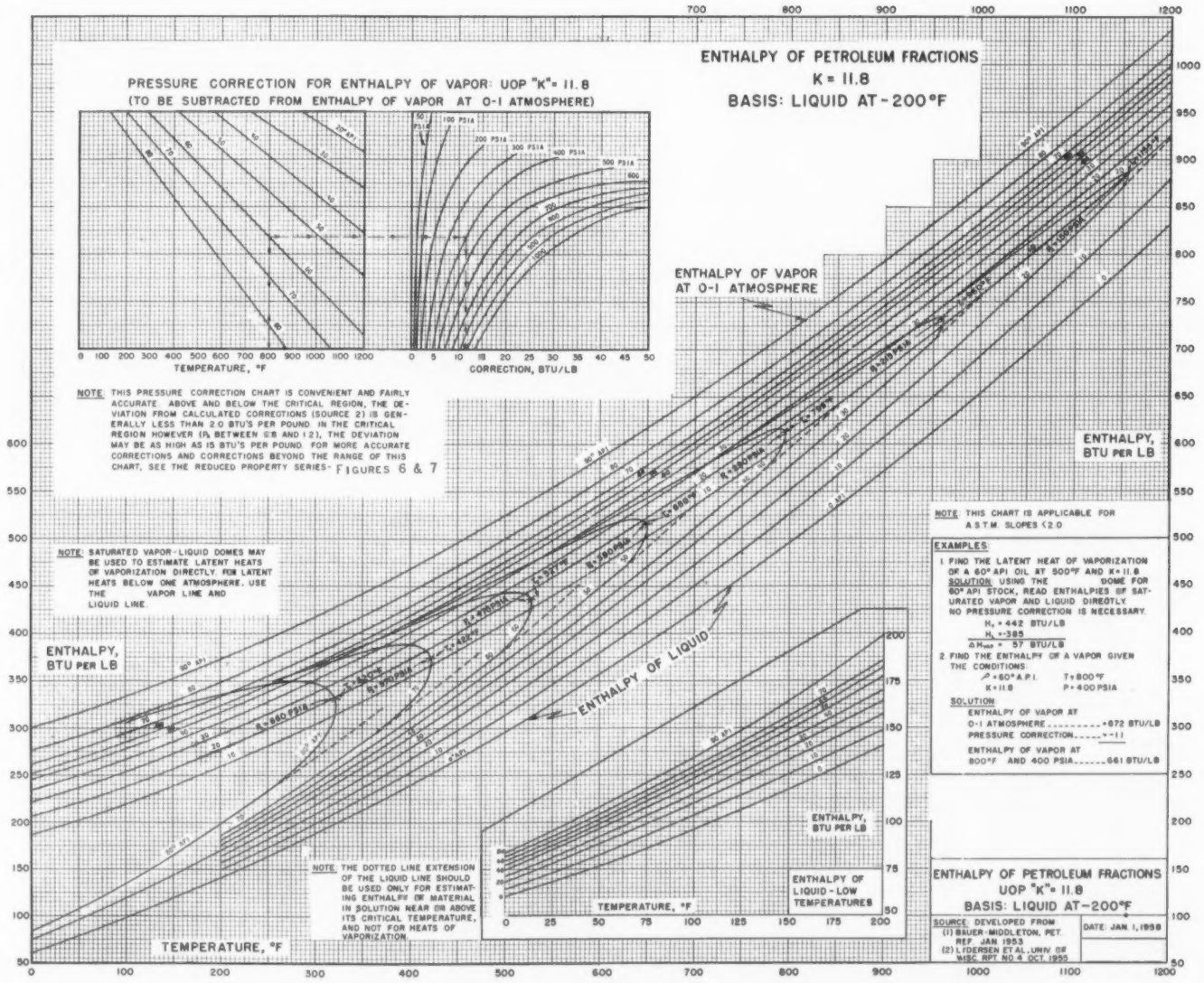
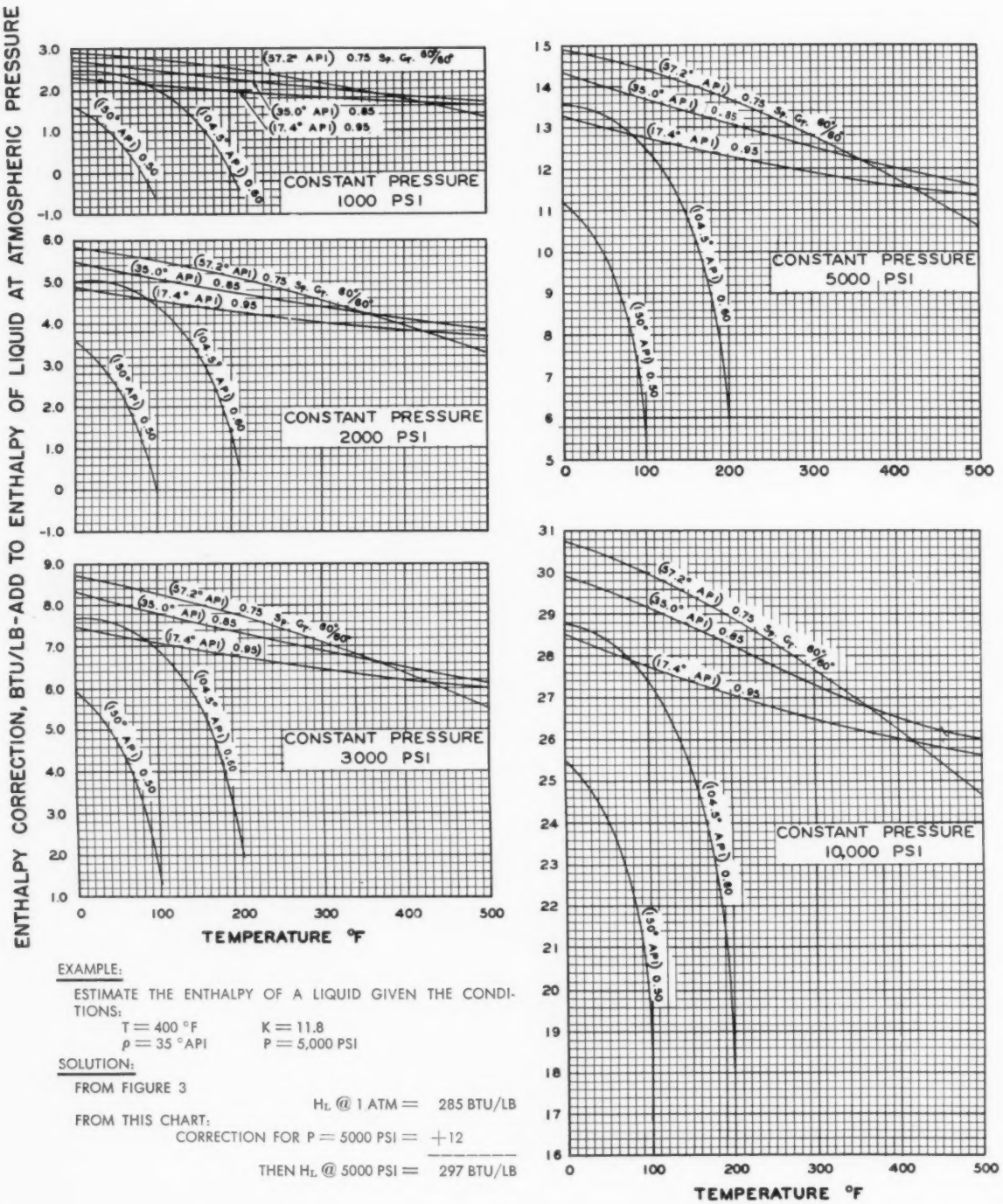

ENTHALPY OF PETROLEUM FRACTIONS
K = 11.8
BASIS: LIQUID AT -200°F
PRESSURE CORRECTION FOR ENTHALPY OF VAPOR: UOP "K" = 11.8
(TO BE SUBTRACTED FROM ENTHALPY OF VAPOR AT 0-1 ATMOSPHERE)
TEMPERATURE, °F
CORRECTION, BTU/LB
NOTE: THIS PRESSURE CORRECTION CHART IS CONVENIENT AND FAIRLY ACCURATE ABOVE AND BELOW THE CRITICAL REGION, THE DEVIATION FROM CALCULATED CORRECTIONS (SOURCE 2) IS GENERALLY LESS THAN 2.0 BTU'S PER POUND IN THE CRITICAL REGION HOWEVER (Pr BETWEEN 0.8 AND 1.2), THE DEVIATION MAY BE AS HIGH AS 15 BTU'S PER POUND. FOR MORE ACCURATE CORRECTIONS AND CORRECTIONS BEYOND THE RANGE OF THIS CHART, SEE THE REDUCED PROPERTY SERIES- FIGURES 6 & 7
ENTHALPY OF VAPOR AT 0-1 ATMOSPHERE
ENTHALPY, BTU PER LB
TEMPERATURE, °F
NOTE: SATURATED VAPOR-LIQUID DOMES MAY BE USED TO ESTIMATE LATENT HEATS OF VAPORIZATION DIRECTLY. FOR LATENT HEATS BELOW ONE ATMOSPHERE, USE THE VAPOR LINE AND LIQUID LINE.
ENTHALPY OF LIQUID
NOTE: THE DOTTED LINE EXTENSION OF THE LIQUID LINE SHOULD BE USED ONLY FOR ESTIMATING ENTHALPY OF MATERIAL IN SOLUTION NEAR OR ABOVE ITS CRITICAL TEMPERATURE, AND NOT FOR HEATS OF VAPORIZATION.
ENTHALPY, BTU PER LB
TEMPERATURE, °F
ENTHALPY OF LIQUID - LOW TEMPERATURES
NOTE: THIS CHART IS APPLICABLE FOR A.S.T.M. SLOPES < 2.0
EXAMPLES:
1. FIND THE LATENT HEAT OF VAPORIZATION OF A 60° API OIL AT 500°F AND K = 11.8
SOLUTION: USING THE 60° API STOCK, READ ENTHALPIES OF SATURATED VAPOR AND LIQUID DIRECTLY. NO PRESSURE CORRECTION IS NECESSARY.
H_v = 442 BTU/LB
H_L = -385
ΔH_vap = 57 BTU/LB
2. FIND THE ENTHALPY OF A VAPOR GIVEN THE CONDITIONS:
ρ = 60° A.P.I. T = 800°F
K = 11.8 P = 400 PSIA
SOLUTION
ENTHALPY OF VAPOR AT 0-1 ATMOSPHERE ..... +672 BTU/LB
PRESSURE CORRECTION ..... -11
ENTHALPY OF VAPOR AT 800°F AND 400 PSIA ..... 661 BTU/LB
ENTHALPY OF PETROLEUM FRACTIONS
UOP "K" = 11.8
BASIS: LIQUID AT -200°F
SOURCE: DEVELOPED FROM (1) BAUER-MIDDLETON, PET. REF. JAN 1953 (2) LIDERSEN ET AL. UNIV. OF WISC. RPT. NO 4 OCT 1955
DATE: JAN. 1, 1958

FIGURE 3—Enthalpy of petroleum fractions. UOP "K" = 11.8. Basis: Liquid at —200°F.


ENTHALPY CORRECTION, BTU/LB-ADD TO ENTHALPY OF LIQUID AT ATMOSPHERIC PRESSURE
TEMPERATURE °F
CONSTANT PRESSURE 1000 PSI
CONSTANT PRESSURE 2000 PSI
CONSTANT PRESSURE 3000 PSI
CONSTANT PRESSURE 5000 PSI
CONSTANT PRESSURE 10,000 PSI
(37.2° API) 0.75 Sp. Gr. 60°/60°
(35.0° API) 0.85
(17.4° API) 0.95
(104.5° API) 0.60
(130° API) 0.50

EXAMPLE:

ESTIMATE THE ENTHALPY OF A LIQUID GIVEN THE CONDITIONS:

$T = 400\ ^\circ F$ $\quad K = 11.8$

$\rho = 35\ ^\circ API$ $\quad P = 5{,}000$ PSI

SOLUTION:

FROM FIGURE 3

H_L @ 1 ATM = 285 BTU/LB

FROM THIS CHART:

CORRECTION FOR P = 5000 PSI = +12

THEN H_L @ 5000 PSI = 297 BTU/LB

FIGURE 5—Isothermal pressure correction to enthalpy of liquid hydrocarbons (Pressure Range of 1,000 to 10,000 PSIA).

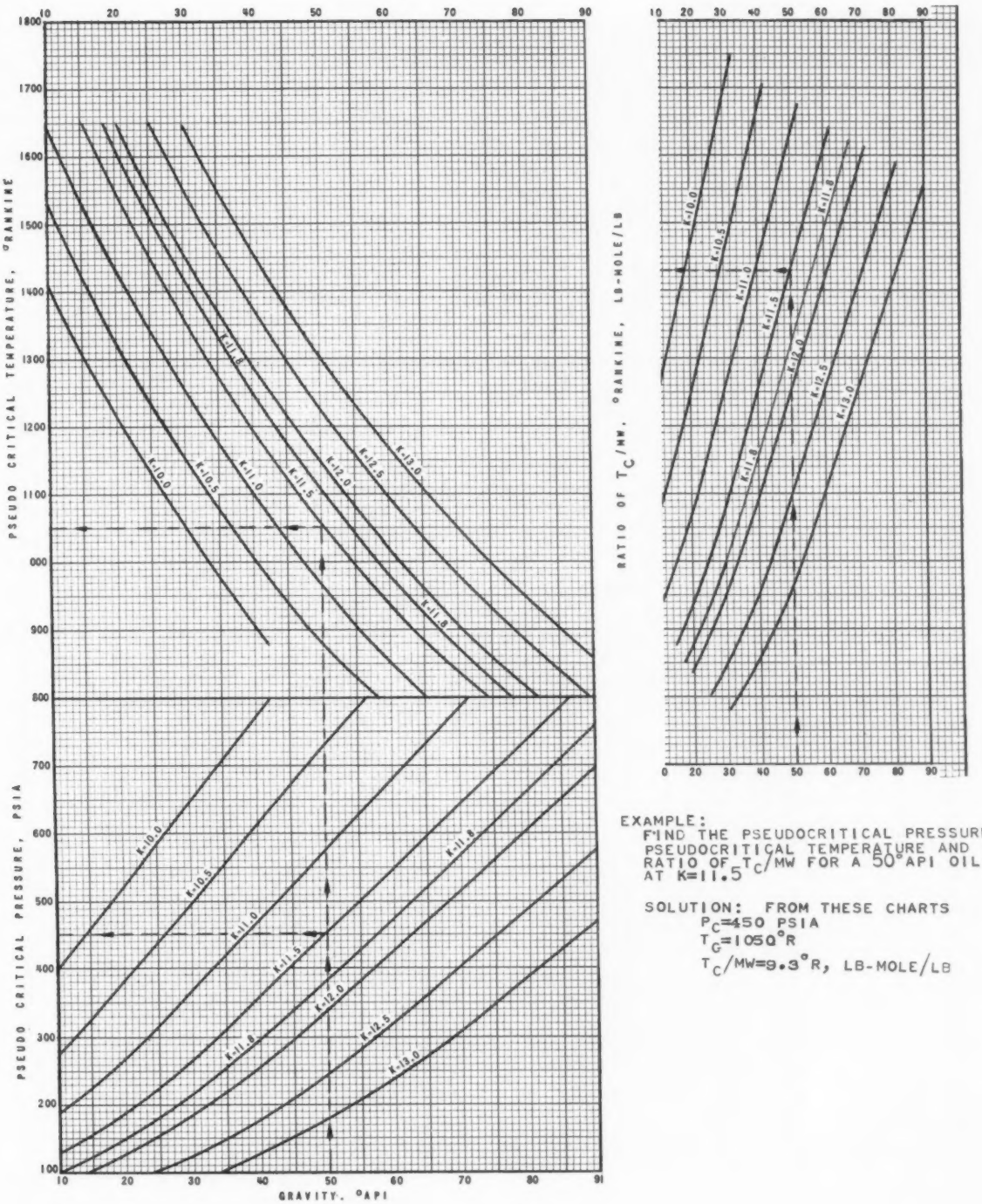


FIGURE 6—Pseudocritical properties of petroleum fractions.

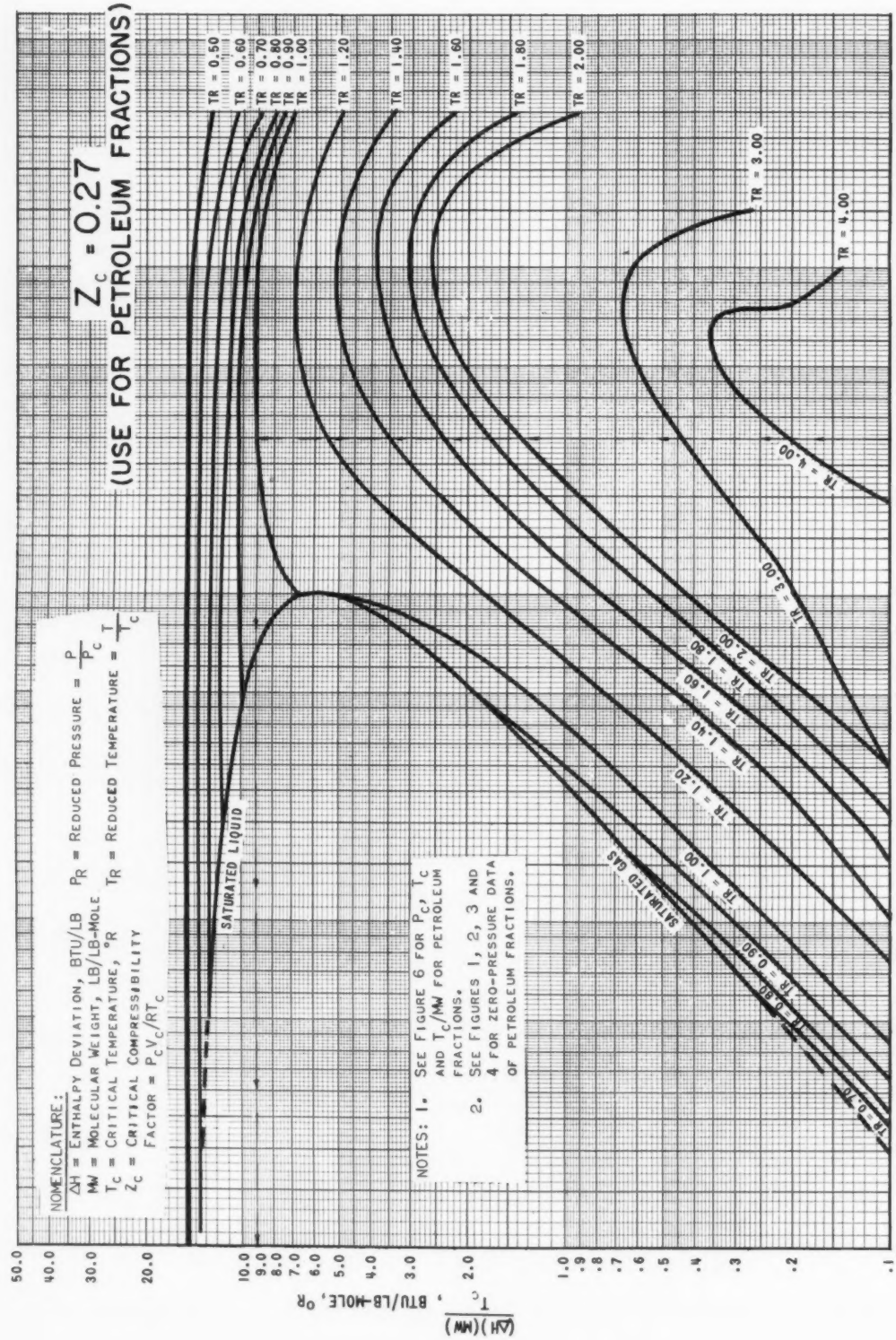

$Z_c = 0.27$
(USE FOR PETROLEUM FRACTIONS)
NOMENCLATURE:
ΔH = Enthalpy Deviation, BTU/LB
MW = Molecular Weight, LB/LB-Mole
T_c = Critical Temperature, °R
Z_c = Critical Compressibility Factor = P_cV_c/RT_c
P_R = Reduced Pressure = P/P_c
T_R = Reduced Temperature = T/T_c
NOTES: 1. See Figure 6 for P_c, T_c and T_c/MW for petroleum fractions.
2. See Figures 1, 2, 3 and 4 for zero-pressure data of petroleum fractions.
SATURATED LIQUID
SATURATED GAS
TR = 0.50
TR = 0.60
TR = 0.70
TR = 0.80
TR = 0.90
TR = 1.00
TR = 1.20
TR = 1.40
TR = 1.60
TR = 1.80
TR = 2.00
TR = 3.00
TR = 4.00
$\frac{T_c}{(\Delta H)(MW)}$, BTU/LB-MOLE, °R
REDUCED PRESSURE, P_R

FIGURE 7—Enthalpy deviation of gases and liquids from zero pressure data ($Z_c = 0.27$).

perature has been computed for stocks with an ASTM slope of 2.0.

The ratio of critical temperature to molecular weight is also provided as a convenient factor to be used with Figure 7 which presents the enthalpy deviation of gases and liquids from zero-pressure data as a function of reduced temperature and pressure. Figure 7 is based on the Lydersen[3] correlation which uses critical compressibility as a third parameter. In these calculations, the critical compressibility of petroleum fractions is assumed to be 0.27.

Knowing the API gravity and characterization factor of a given petroleum fraction, the pseudocritical temperature, pseudocritical pressure and ratio of critical temperature to molecular weight are read directly from Figure 6. The reduced temperature and pressure are then calculated from operating conditions. From the reduced conditions, Figure 7 is used to estimate the enthalpy deviation in terms of:

$$\frac{\Delta H \times MW}{T_c}, \text{ Btu/(lb. mole) (°R)}$$

where:

ΔH = Enthalpy deviation from zero pressure data, Btu/lb.
MW = Molecular weight, lbs./(lb. mole)
T_c = Pseudo-critical temperature, °R.

This expression gives the enthalpy deviation in Btu/lb. when multiplied by the factor T_c/MW obtained from Figure 6. This deviation is then subtracted from the appropriate zero-pressure data to give the enthalpy of the petroleum fraction at a given set of operating conditions. An example of the use of Figure 7 is as follows:

Example: Estimate the enthalpy of a vapor given the conditions:

$\rho = 50°$ API K = 11.5
T = 590° F P = 1350 psia

Solution: Use Figures 2 and 3 to get H_V @ 590 °F and 0-1 atm.

H_v @ 0-1 atm $\frac{K = 11.0}{514}$ $\frac{K = 11.8}{525}$ $\frac{K = 11.5}{521}$

The pressure correction at 1350 psia is beyond the range of the runaround charts so—

From Figure 6:

$T_c = 1050°$ R $P_c = 450$ psia
$T_c/MW = 9.3$ °R — mole

Then calculate P_r and T_r:

$P_r = 1350/450 = 3.0$
$T_r = 1050/1050 = 1.0$

From Figure 7:

$$\frac{\Delta H(MW)}{T_c} = 9.0$$

$\Delta H = 9.0 \times 9.3 = 84$ Btu/lb.

Then $H_v = 521 - 84 = 437$ Btu/lb.

Conclusions. The series of charts presented provide a convenient package for estimating the enthalpy of petroleum fractions. The charts are clear, concise, and easy to read and use. Their use offers the following advantages over earlier methods of presentation:

1. Eliminates separate correction for characterization factor.
2. Pressure corrections are based on more recent data.
3. Permits direct estimation of heats of vaporization.
4. Provides pictorial view of phase relations.
5. Reduces time and number of corrections required to obtain enthalpy data for petroleum fractions.

ACKNOWLEDGMENT

The authors wish to express their appreciation to the Socony Mobil Oil Company, Inc. for permission to publish this article. The assistance of the Engineering Department and in particular, the guidance, criticism and suggestions of Messrs. V. O. Bowles, W. F. Read and E. R. J. Sorf is gratefully acknowledged.

NOMENCLATURE

UOP "K" = Characterization Factor = $\frac{\sqrt[3]{\text{cubic average B.P., °R}}}{\text{Specific Gravity } 60°/60°}$

T_r = Reduced Temperature = $\frac{\text{Operating Temperature, °R}}{\text{Pseudo Critical Tem., °R}}$

P_r = Reduced Pressure = $\frac{\text{Operating Pressure, psia}}{\text{Pseudo Critical Pressure, psia}}$

T_c = Pseudo Critical Temperature, °R

P_c = Pseudo Critical Pressure, psia

MW = Molecular Weight, lbs./(lb. mole)

H_L = Enthalpy of liquid, Btu/lb.

H_V = Enthalpy of vapor, Btu/lb.

λ = Heat of vaporization, Btu/lb.

ΔH = Enthalpy deviation from zero pressure data, Btu/lb.

LITERATURE CITED

[1] Bauer, C. R. and Middleton, J. F., Enthalpy of Petroleum Fractions, Petroleum Refiner, 32, No. 1, p. 111 (1953).
[2] Maxwell, J. B., Data Book on Hydrocarbons, Esso Research and Engineering, (Esso) 5th Printing (1958) p. 114-127.
[3] Lydersen, A. L., Greenkorn, R. A., and Hougen, O. A., "Generalized Thermodynamics Properties of Pure Fluids," University of Wisconsin, Engineering Experimental Station, Rept. No. 4, Oct. 1955.
[4] Watson, K. M., I.E.C. 23, 360 (1931); 35, 398 (1943).
[5] Holcomb, and Brown, I.E.C., 34, 592 (1942).
[6] Smith, R. L., and Watson, K. M., "Boiling Points and Critical Properties of Hydrocarbon Mixtures," I.E.C., 29, p. 1408 (1937).

A reprint of this article, including Figures 1, 2, 3 and 4 in three colors, is available for 75 cents from Reprint Department, PETROLEUM REFINER, P. O. Box 2608, Houston 1, Texas. Please remit with order.

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New Chart for Packed Tower Flooding

A rearrangement of the basic Sherwood correlation gives a plot which is simpler to use and gives more intelligent extrapolation at higher gas and liquid rates

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SINCE 1938 the basic correlation of Sherwood, Shipley and Holloway for predicting flooding in countercurrent gas-liquid flow through packed towers, has retained its original format with only minor modifications. A second glance at the grouping of variables indicates that this can simply be rearranged to a plot of volumetric gas flow versus volumetric liquid flow. When plotted in this manner, it permits simpler use, more intelligent extrapolation, and points out ambiguities in some of the earlier published modifications of the original curve.

The generally accepted flooding correlation developed and published by Sherwood, Shipley and Holloway[2] in 1938 is illustrated in Figure 1. Modifications of the original curve have been published by Lobo et al.[1] and by Zenz[3] based on presumed improvements in the treatment of the experimental data entering into the correlation. However, the groupings of the variables in abscissa and ordinate have apparently withstood the tests of time and re-analyses.

It is difficult to fully visualize the effect of gas and liquid rates independently in a plot such as Figure 1, since the gas rate appears in both the abscissa and the ordinate. By a simple rearrangement plotting

$$(\text{abscissa}) \cdot (\text{ordinate})^{1/2} \text{ versus } (\text{ordinate})^{1/2} \qquad (1)$$

the variables can be separated and the result shown to expose the correlation as essentially a plot of volumetric gas rate versus volumetric liquid rate.

The abscissa may be written as

$$\frac{L}{G}\sqrt{\frac{\rho_G}{\rho_L}} = \frac{L}{U_o\rho_G}\sqrt{\frac{\rho_G}{\rho_L}}, \qquad (2)$$

and the square root of the ordinate as

$$U_o\sqrt{\frac{\rho_G}{\rho_L}}\sqrt{\frac{a}{F^3}\frac{\mu_L^{0.2}}{g}} \qquad (3)$$

so that the product of (2) and (3) gives

$$\left(\frac{L}{U_o\rho_G}\sqrt{\frac{\rho_G}{\rho_L}}\right)\left(U_o\sqrt{\frac{\rho_G}{\rho_L}}\sqrt{\frac{a}{F^3}\frac{\mu_L^{0.2}}{g}}\right) = \frac{L}{\rho_L}\sqrt{\frac{a}{F^3}\frac{\mu_L^{0.2}}{g}} \qquad (4)$$

Converting L/ρ_L to more conventional volumetric units for liquid flow:

$$7.481 \times 60 \times \text{Equation (4)} = \left(\frac{GPM}{ft^2}\right)\sqrt{\frac{a}{F^3}\frac{\mu_L^{0.2}}{g}} \qquad (5)$$

Equation (1) is therefore equivalent to a plot of Equation (3) versus Equation (5). This is represented in Figure 2 for the same three curves shown in Figure 1. The gravitational constant g has been incorporated numerically in both abscissa and ordinate and therefore does not appear in the correlants; the symbol Q refers to volumetric liquid flow in gallons per minute per square foot and the symbol V to gas flow in cubic feet per minute per square foot.

This manner of plotting the flood-

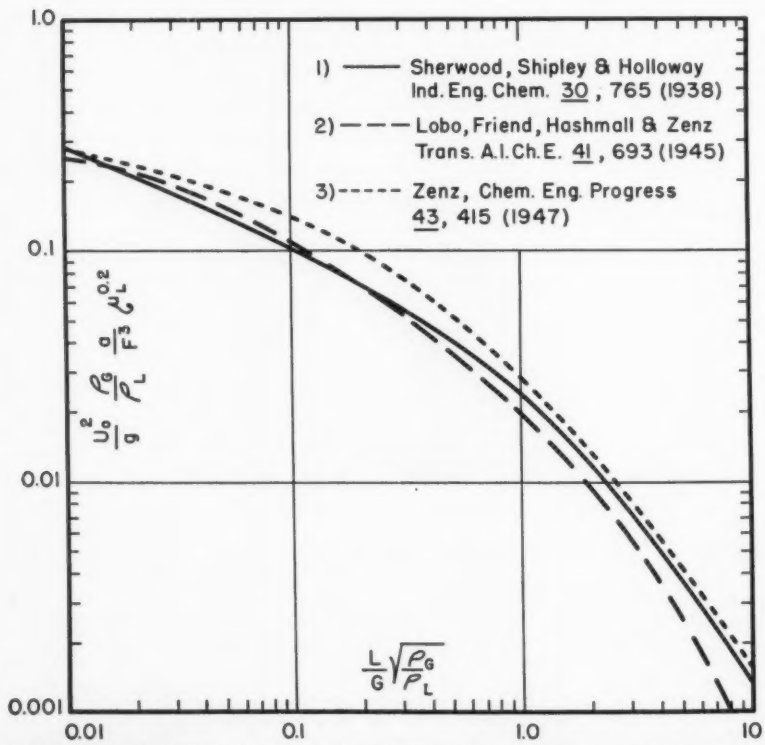

FIGURE 1—It is difficult to fully visualize the effect of gas and liquid rates independently in this plot since the gas rate appears in both the abscissa and the ordinate.

ing correlation exposes the basic independent variables and indicates that casual extrapolations of the curves in Figure 1 (so frequently necessary in practice) can easily lead to erroneous results. Consider for example the curve drawn by Lobo et al. in Figure 1. This curve, converted to the plot shown in Figure 2 indicates a curvature at high values of the abscissa which would permit prediction of two different flooding gas rates at the same liquid rate. Conversely one would calculate the same liquid flooding rate at two widely differing gas rates. This ambiguity is simply a result of incorrect extrapolation of the curve in Figure 1, which is not obvious from Figure 1 alone. Figure 2 is also of particular interest because the factor $CFM/\sqrt{\rho_L/\rho_G}$ is the basic parameter in sizing bubble cap trays.

The simplified rearrangement of the Sherwood et al. correlation shown in Figure 2 explains the reported rule of thumb[4] that for a given vapor-liquid system and a given packing

$$\sqrt{V} + \sqrt{Q} = \text{Constant} \qquad (6)$$

Since the packing factor a/F^3 appears in both abscissa and ordinate of Figure 2, its effect is simply to move the entire curve diagonally to the upper right or lower left; it does not affect the shape of the curve. Similarly for a given vapor-liquid system $\sqrt{\rho_L/\rho_G}$ is also a constant, moving the curve up or down in a vertical direction but again not changing its shape. Equation (6) can therefore be represented on the coordinates of Figure 2 as shown in Figure 3 in comparison with the curve based on Zenz' analysis of "upper break point" flooding data. Though stumbled upon empirically, it is now obvious that Equation (6) actually represented an appreciation of the basic variables and that the constant is simply related to

$$1/(\mu_L^{0.2}\, a/F^3), \text{ and to } \sqrt{\rho_L/\rho_G}$$

As reported in the literature,[4] the constant increases with increase in packing size and decreases with increase in liquid viscosity. The shape of the curve representing Equation (6) in Figure 3 is based on an arbitrary value of the constant chosen to emphasize how well Equation (6) can fit the correlation curve. In this case $\sqrt{\rho_L/\rho_G}$ was taken as 28.6 based on an air-water system.

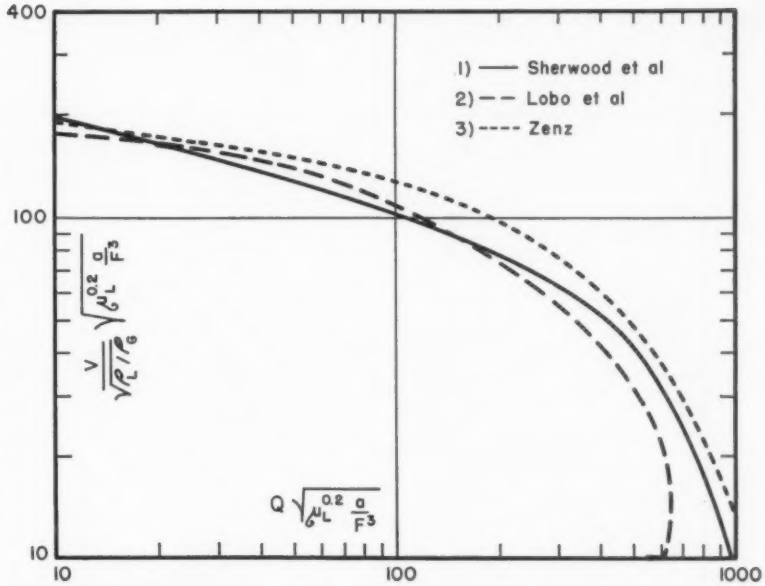

FIGURE 2—This alternate plot of flooding velocity, while putting gas and liquid on separate ordinates, merely moves the entire curve diagonally to the right or left.

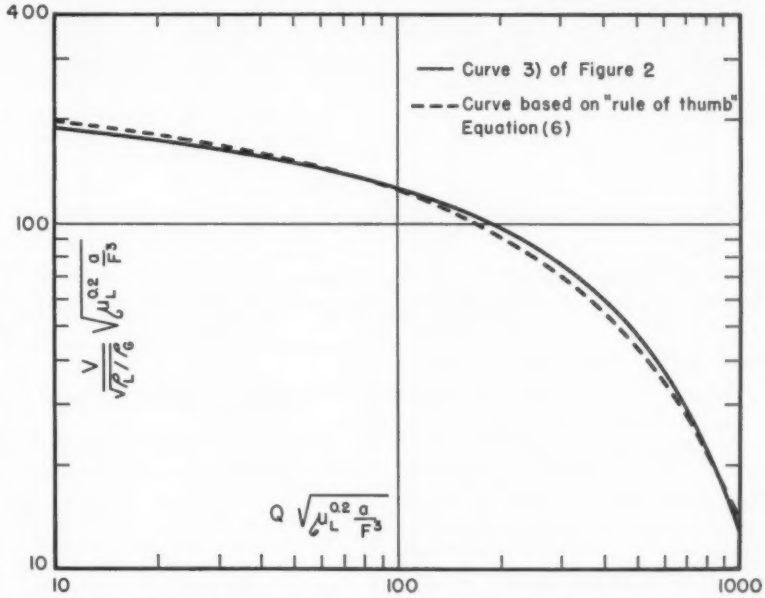

FIGURE 3—Notice how well the empirical flooding correlation curve corresponds with the "Rule of Thumb" additive relationship of Equation (6).

Accepting the "upper break point" curve as the correlating curve, and introducing the factor $\sqrt{\mu_L^{0.2} a/F^3}$ as a parameter, a more useful chart for design purposes can be drawn up in the form shown in Figure 4. The simple use of this chart can be illustrated by the following problem.

EXAMPLE

It is desired to scrub 765 cfm (at actual operating temperature and pressure) of gas having a density of 0.1 lbs/cu ft with 234 gpm of liquid having a viscosity of 1 centipoise and a density of 50 lbs/cu ft, in a tower packed with 1 inch Raschig rings (for which $a/F^3 = 160$). From Figure 4

$$Q/(V/\sqrt{\rho_L/\rho_G}) = 234/(765/\sqrt{50/0.1}) = 6.85 \text{ and } \mu_L^{0.2}\, a/F^3 = 160$$

Read either ordinate as 3.8 or ab-

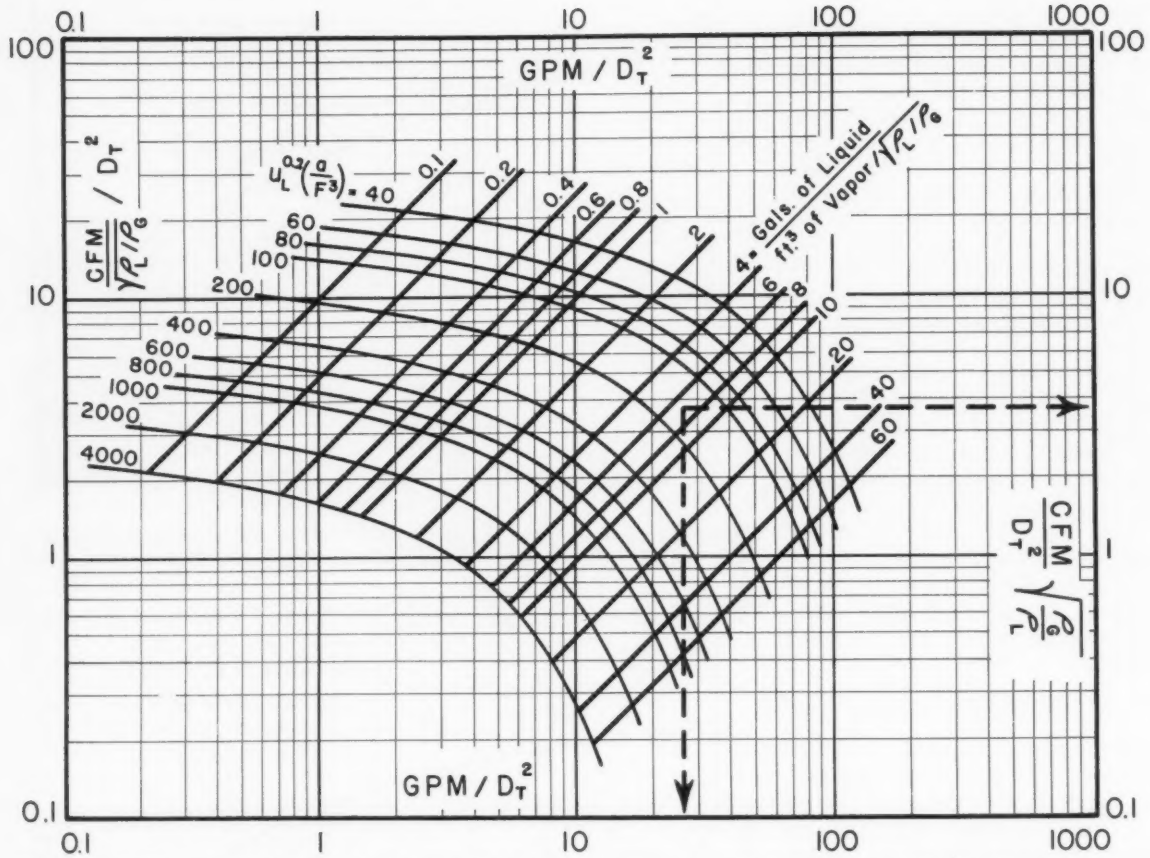

FIGURE 4—This simplified design chart for packed tower flooding rates is based on accepting the "upper break point" curve as the correlating curve, and introducing the factor $\sqrt{\mu_L^{0.2}\, a/F^3}$ as a parameter.

scissa as 26. Tower diameter is therefore

$$\sqrt{234/26} = 3 \text{ feet or}$$
$$\sqrt{(765/\sqrt{50/0.1})/3.8} = 3 \text{ feet}$$

The simplified solutions of other variants of the general problem are obvious.

NOMENCLATURE

- a = packing surface, sq ft/cu ft of packed volume
- D_T = tower diameter, feet
- F = void fraction in dry bed of packing
- G = gas mass flow rate, lbs/sec x ft²
- g = gravitational constant, ft/sec²
- L = liquid mass flow rate, lbs/sec x ft²
- Q = liquid volumetric flow rate, gallons/minute x sq ft of superficial tower cross sectional area
- Uo = superficial gas velocity through tower, ft/sec
- V = gas volumetric flow rate, cubic feet/minute x sq ft of superficial tower cross sectional area
- ρ_G = gas density, lbs/cu ft
- ρ_L = liquid density, lbs/cu ft
- μ_L = liquid viscosity, centipoises

LITERATURE CITED

[1] Lobo, W. E., Friend, L., Hashmall, F., Zenz, F. A., Trans. A.I.Ch.E., 41, 693-710 (1945).
[2] Sherwood, T. K., Shipley, G. H., Holloway, F. A. L., Ind. Eng. Chem., 30, 765-9 (1938).
[3] Zenz, F. A., Chem. Eng. Progress, 43, 415-28 (1947).
[4] Zenz, F. A., Chem. Engineering, 60, No. 8, 177-84 (1953).

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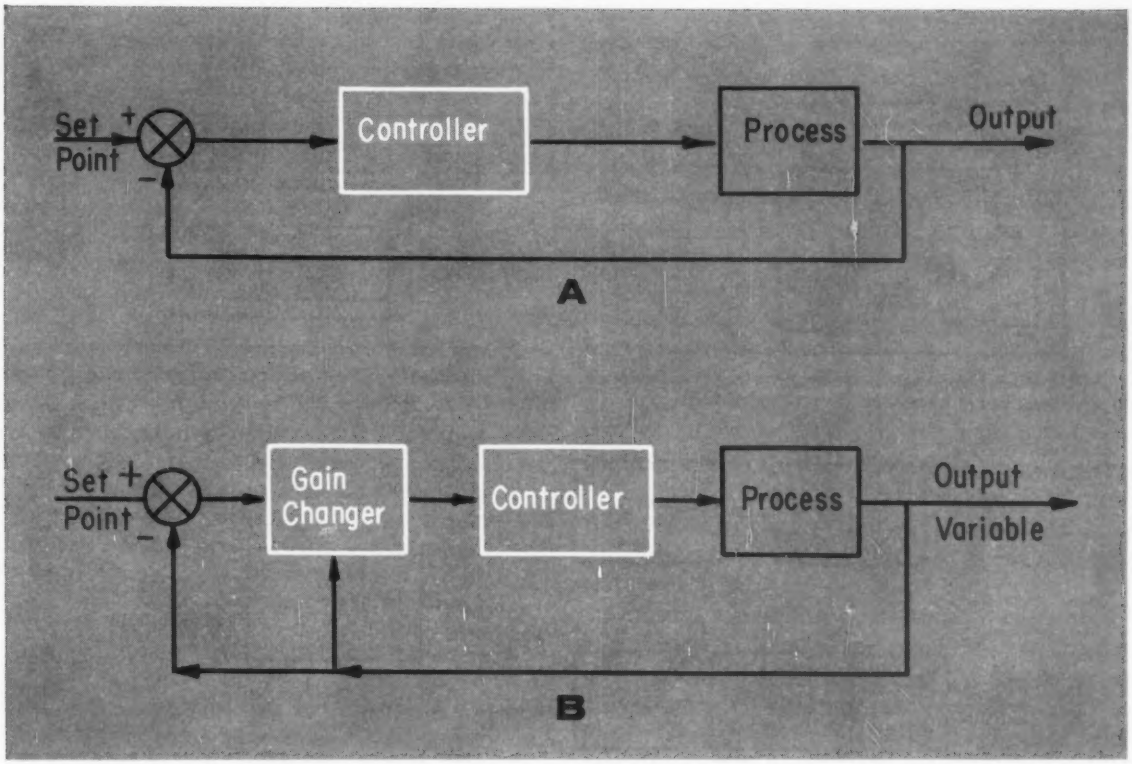

FIGURE 180—By adding a gain control the overall controller is able to adapt itself to varying conditions of the process. Here the standard control system (A) is compared with an adaptive control system (B).

PART 25

Automation Today

Adaptive control is one of the most refined methods of control. With this method a controller can adjust itself to compensate for varying conditions within a process. Here are some examples of adaptive control

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IN A STANDARD control system (Figure 180A), the controller settings are not affected by the action of the process or other system being controlled. The actual process output is compared with the desired output value or set point and any resulting error is used by the controller to vary some input to the process. However, if in addition to this some parameter of the controller can also be changed by the actions of the process so as to aid the controllability of the process, the system then becomes one of the adaptive types. (Figure 180B).

Adaptive control is one of the most refined methods of control and as a result requires that the resulting control system be more complex than many of the cases we studied earlier. Although we will not attempt to discuss thoroughly the mathematics required to implement the use of adaptive control, we will seek to illustrate some of the simpler schemes of control and their uses.

The lack of application of a single definition for adaptive control early in its development has caused the word now to mean many different things to different groups studying it. For this reason, four separate definitions have become common[1] and are given in the accompanying box.

SOME EXAMPLES OF GAIN CHANGE

The example used in Part 24 is an illustration of a simple adaptive process along with being an example of a nonlinear one. The operation of this particular sys-

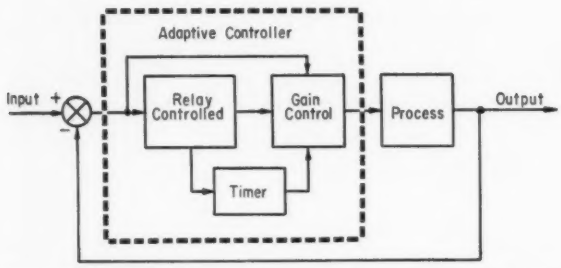

FIGURE 181—This control system is extremely valuable for situations where overshoot is very undesirable.

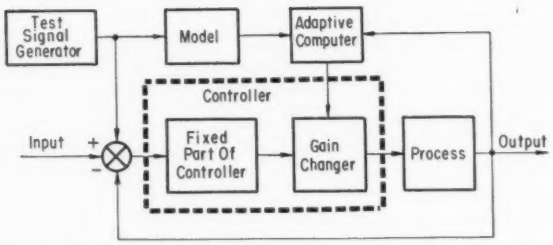

FIGURE 182—One form of adaptive control uses two control loops and an outside signal.

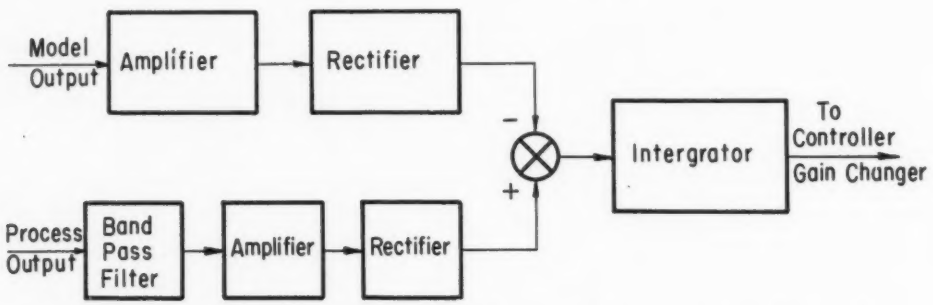

FIGURE 183—This controller will vary the gain to maintain a constant amplitude ratio.

tem in block diagram form is shown in Figure 180B. By such an arrangement we can allow the controller to correct for the effect of having a nonlinear valve in the system by changing the controller gain. The controller is thus able to "adapt" itself to varying conditions of the process and to meet some "measure of merit" of operation of the control system. In this case, the "measure of merit" is a constant total gain for the system. The controller adapts itself to changing process gain by inversely varying its own gain thereby maintaining a constant over-all gain throughout the range of operation of the system and therefore a constant control response.

Another system of gain control[2] has also been used to improve control over and above that possible by standard methods. This controller is unique in that it has a relay controlled output and also because it changes its controller gain at some selected time *after* the system output changes. The entire system in block diagram form is shown in Figure 181.

For large errors the corrective force is applied all of the time. As the error decreases the system will eventually find itself within an intermediate error region. In this range of error the relay in the system is used to alternately turn on the control function for a fixed period and then to allow the system to "coast" another fixed period. This corrective action is continued until the system has reached some static error value, hopefully close to the setpoint. Such a system allows no corrective action to occur in the region near the set point.

The equations of operation for this type of system may be described as follows:

For large error, i.e., ($|\text{Error}| > |E_1|$)

$K_p = K_1$, where
K_p = proportional gain, and
K_1 = a fixed maximum gain value continually applied, and
E_1 = dynamic deadband limit

For intermediate errors, i.e., ($|E_1| > |\text{Error}| > |E_2|$)

$K_p = K_1$ for T_1:
$= 0$ for T_2, where
T_1 = action time for the controller, i.e., controller on
T_2 = rest time for the controller, i.e., controller off
E_2 = static deadband

T_1 and T_2 alternate whenever the error is within the dynamic deadband range.

For small error, ($|\text{Error}| < E_1$)

$K_p = 0$, and controller is always off

This system of control which allows fast return to an area near the setpoint, with no overshoot past the set point, can be extremely valuable then for those control situations where any overshoot whatsoever would be very undesirable. An example is some reactor systems where heat sensitive products are present.

CONTROL CORRECTION BY SINUSODIAL RESPONSE

A system of adaptive control[3] containing two loops, one the primary or main control loop and the other an adaptive or secondary control loop, can often be used to correct a control setting by measuring its response to a particular input. One possibility for the interconnection of these loops is illustrated in Figure 182. In operation

a sinusoidial test signal is used to perturb the system by adding it to the primary control loop and at the same time feeding it to a model system which gives the type of response desired for the main system being controlled.

The output of the primary loop and the output of the model are compared and the resulting difference is used to correct the gain of the control loop. Two types of error detection for the above task are commonly used. These are: either (1) a constant amplitude ratio, or (2) a constant phase angle between the model output and the process output is maintained.

Controller Gain Change to Maintain Constant Test Signal Amplitude. The adaptive computer takes on a special form for the case of control of a constant amplitude ratio as shown in Figure 183. The output of the system is first filtered to remove all but the test signal. The resulting "clean" signal is then amplified and rectified. The model output is amplified and also rectified. The two rectified signals are then compared (i.e., subtracted). The resulting error is integrated and used as a signal for changing the controller gain in the primary loop until the output of the model and the system are the same (i.e., an amplitude ratio of 1 is obtained).

Controller Gain Change to Maintain Constant Phase Shift. When the adaptive controller is to use a constant phase-shift measurement it generally assumes the form shown in Figure 184. The model output is first phase-shifted and amplified. The process output is filtered as before to remove all but the test signal and the resulting signal is also amplified as necessary. The resulting signals are then multiplied together and the product is integrated and used as the input to the controller gain changer.

AN OPTIMIZING ADAPTIVE SYSTEM

A typical system of adaptive control[4] comprises a complete adaptive control arrangement which measures certain variables of the process, compares them with established "figures of merit" of the system and then changes the system parameter in order to force the measured "figure of merit" variables toward the optimum point of operation of the complete system. A complete block diagram of the resulting system is shown in Figure 185. The method of determining the optimum point is usually by means of cross-correlation or perturbation techniques.[5,6] Optimizing systems are usually of such complex nature that computers are needed to carry out the necessary calculations. A discussion of computers and their uses in optimizing chemical processes will be discussed in the next part of this series. Because adaptive control and optimization occur hand-in-hand, a simple optimizing example will now be discussed.

An Example of Optimization. A well known system originally discussed by Eckman and Lefkowitz[7] shows the problems involved in chemical process optimization. This problem has been modified to some extent and will be presented in this form.

One of the most important factors in batch process optimization is the total processing time. Time determines labor, overhead, and appropriated plant investment charges. Where material and energy costs are relatively independent of the processing conditions, the case for many batch processes, time is the controlling cost factor.

The total processing time is expressed as an integral of some function of the composition variables.

$$t_f = \int_0^{v_f} F\,(u', u, v)\,dv \qquad (1)$$

where

t_f = total processing time
v_f = final product composition value
u, v = composition variables
$u' = \frac{du}{dv}$

Adaptive Control — Here are some definitions for it

1. Adaptive control is a method of control which is aimed at obtaining an optimum system performance even when there is present only an incomplete or inexact analytical or analog model of the process that is to be controlled.

2. The term "Adaptive" is applied to any control system which measures the system either continuously or intermittently in order to develop the impulse response or some other experimentally obtained function which characterizes the process, and which then in turn uses this system-characteristic function to determine and to generate the necessary forcing function to cause the system to behave in a desired manner.

3. A feed back control system is adaptive if it can perform independently of the value of a variable x over any finite interval of the system variable x.

4. An adaptive system is any physical system which has been designed so as to have some self-changing or self-altering characteristics.

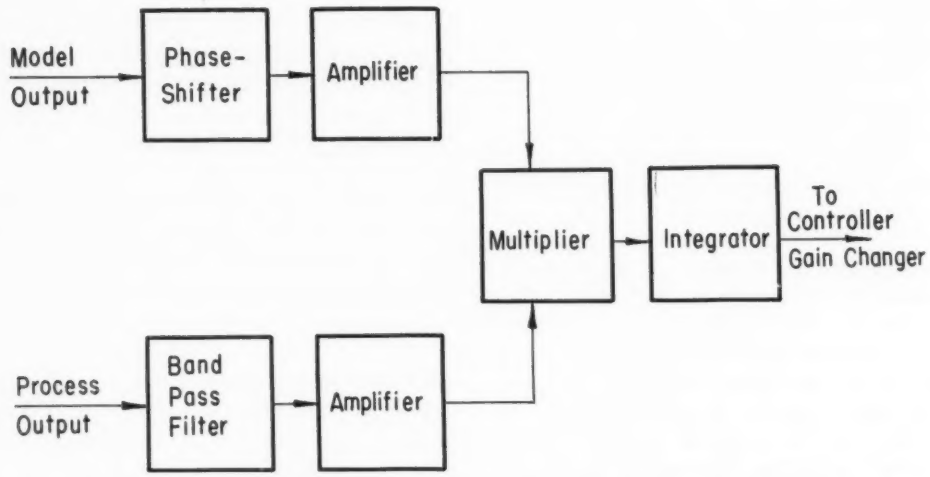

FIGURE 184—Another form of adaptive control will change the gain to maintain constant phase shift.

The necessary condition for a minimum of the integral equation is determined by the Euler-Lagrange relation[8]

$$\frac{\partial F}{\partial u} - \frac{d}{dv}\left(\frac{\partial F}{\partial u'}\right) = 0 \qquad (2)$$

where

$$F = F(u', u, v)$$

This equation is subject to those restrictions on the magnitudes of the composition variables which are necessary to satisfy the initial and final values of the process and determine the optimum processing path. It should be noted that applying the Euler-Lagrange relation provides only a necessary condition for the minimizing function. The possibility of the function obtained to be a maximum is excluded by the nature of the physical system. (i.e., maximum processing time is necessarily infinite since operating conditions can be specified which would make the processing rate infinitesimal).

Consider a process with the following reactions occurring

$$(A) + (B) \xrightarrow{k_1} (C) \qquad (3)$$

$$(C) + (B) \xrightarrow{k_2} (D) \qquad (4)$$

These are two first order reactions occurring at the rates of k_1 and k_2 respectively. By the application of the material balance relation the differential equations are

$$dx/dt = -k_1 x, \text{ where x represents component (A).} \qquad (5)$$

$$dy/dt = k_1 x - k_2 y, \text{ where y represents component (C).} \qquad (6)$$

provided component B is in excess.

For a constant pressure process and assuming the solubility remains unchanged with temperature, the rate equations in Arrhenius form become

$$k_1 = A_1 e^{-B_1/T} \qquad (7)$$

$$k_2 = A_2 e^{-B_2/T} \qquad (8)$$

where A and B are the usual kinetic factors, (i.e., collision factor and activation energy terms).

T is the absolute temperature.

It is now necessary to evaluate the appropriate relations to determine the minimum process time to produce a given final composition.

Let

$$u = y/x, \qquad (9)$$

and

$$v = \ln (x_i/x) \qquad (10)$$

Then

$$x = x_i e^{-V}, \qquad (11)$$

and

$$dx/dt = -x_i e^{-V} dv/dt \qquad (12)$$

Substituting Equations (11) and (12) into Equation (5) yields

$$x_i e^{-V} dv/dt = k_1 x_i e^{-V}.$$

Now

$$dv/dt = k_1. \qquad (13)$$

Also from Equation (9)

$$y = ux \quad \text{and}$$

$$dy/dt = u\, dx/dt + x\, du/dt. \qquad (14)$$

Substituting Equation (9), (12) and (14) into Equation (6) yields

$$u(-x_i e^{-V} k_1) + x_i e^{-V} du/dt = k_1 x_i e^{-V} - k_2 u (x_i e^{-V}),$$

and then collecting terms gives

$$du/dt = k_1 u + k_1 - k_2 u. \qquad (15)$$

Equations (13) and (15) are separate equations in u and v which we will now solve together by the calculus of variation to determine the optimum t_f (time of reaction).

Rearranging Equation (13) gives

$$dt = dv/k_1 \quad \text{or}$$

$$t_f = \int_{v_i}^{v_f} dv/k_1 \tag{16}$$

The optimization of this equation subject to a constraint (Equation 15) will yield the desired optimum in t.

All that remains is to determine the function F where

$$\int_{v_i}^{v_f} \frac{dv}{k_1} = \int_{v_i}^{v_f} F\,(u, u', v)\,dv$$

and where

$$u' = du/dv.$$

Combining Equations (13) and (15) gives

$$(du/dt)\,(dt/dv) = du/dv = u + 1 - (k_2/k_1)u$$

If we let

$$K = k_2/k_1,$$

then

$$du/dv = (1 - K)\,u + 1 \tag{17}$$

or

$$K = \frac{u - u' + 1}{u} \tag{18}$$

Since the function of F requires $\frac{1}{k_1}$, Equation (18) must be altered to be a function of k_1 rather than K.

Raising Equation (8) to the $1/B_2$ power yields

$$k_2^{1/B_2} = A_2^{1/B_2}\,e^{-1/T} \tag{19}$$

Raising Equation (7) to the $1/B_1$ power yields

$$k_1^{1/B_1} = A_1^{1/B_1}\,e^{-1/T} \tag{20}$$

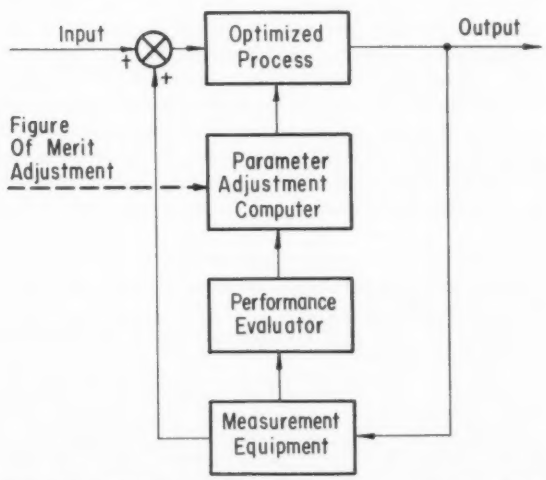

FIGURE 185—Optimizing control systems are usually of such complex nature that computers are needed to carry out the necessary calculations.

Dividing Equation (19) by (20), gives

$$\frac{k_2^{1/B_2}}{k_1^{1/B_1}} = \frac{A_2^{1/B_2}}{A_1^{1/B_1}}$$

or

$$k_1^{1/B_1} = k_2^{1/B_2}\left(\frac{A_1^{1/B_1}}{A_2^{1/B_2}}\right) = (K\,k_1)^{1/B_2}\left(\frac{A_1^{1/B_1}}{A_2^{1/B_2}}\right)$$

Thus

$$k_1^{[(1/B_1)\,-\,(1/B_2)]} = K^{1/B_2}\left(\frac{A_1^{1/B_1}}{A_2^{1/B_2}}\right)$$

from which we obtain

$$k_1 = K^{(B_1/(B_2-B_1))}\left(\frac{A_1^{(B_2/(B_2-B_1))}}{A_2^{(B_1/(B_2-B_1))}}\right) \tag{21}$$

Now let

$$\frac{1}{M} = \left(\frac{A_1^{(B_2/(B_2-B_1))}}{A_2^{(B_1/(B_2-B_1))}}\right), \text{ and } n = -\,(B_1/(B_2 - B_1)) \tag{22}$$

then

$$\frac{1}{k_1} = M\,K^n \tag{23}$$

From Equations (23) and (18) it is obvious that

$$F(u,u',v) = \frac{1}{k_1} = MK^n = M\left(\frac{u - u' + 1}{u}\right)^n \tag{24}$$

Applying the Euler-Lagrange condition to Equation (24), gives us

$$\frac{\partial}{\partial u}(MK^n) - \frac{d}{dv}\left(\frac{\partial}{\partial u'}(MK^n)\right) = 0$$

or

$$\frac{\partial}{\partial u}(K^n) - \frac{d}{dv}\left(\frac{\partial}{\partial u'}(K^n)\right) = 0 \tag{25}$$

Differentiating to obtain the terms in Equation (25) gives

$$\frac{\partial K^n}{\partial u} = \frac{n\,K^{n-1}\,(u' - 1)}{u^2}$$

$$\frac{\partial K^n}{\partial u'} = -\frac{n\,K^{n-1}}{u}$$

$$\left(\frac{d}{dv}\right)\left(\frac{\partial K^n}{\partial u'}\right) = \frac{n\,(1-n)\,K^{n-2}\,u\,K' + nK^{n-1}\,u'}{u^2}$$

$$= \frac{n\,K^{n-1}}{u^2}\left[u\,(1-n)\frac{d\ln K}{dv} + u'\right]$$

$$= \frac{n\,K^{n-1}}{u^2}\left[u\,(1-n)\left\{\frac{1}{K}\left(\frac{-u\,u'' + u'^2 - u'}{u^2}\right)\right\} + u'\right]$$

$$= \frac{n\,K^{n-1}}{u^2}\left[\frac{(1-n)\,(u'^2 - u\,u'' - u'}{u - u' + 1} + u'\right]$$

Now substituting into Equation (25), the result is

$$\frac{n\,K^{n-1}}{u^2}(u' - 1) = \frac{n\,K^{n-1}}{u^2}\left[\frac{(1-n)\,(u'^2 - u\,u'' - u')}{u - u' + 1} + u'\right]$$

Combining terms (assuming $K \neq 0$), we get

$$(1-n)\,u\,u'' - (1-n)\,u'^2 + (2-n)\,u' - (u+1) = 0 \tag{26}$$

Differentiating Equation (17),

$$u'' = u' - K u' - K' u, \text{ where } K' = \frac{dK}{dv} \qquad (27)$$

Substituting Equation (27) into Equation (26) and combining terms, results in

$$(1-n)(u u' - K u u' - K' u^2 - u'^2 + u') + u' - u - 1 = 0 \qquad (28)$$

but

$$K = \frac{u - u' + 1}{u}$$

Therefore Equation (28) becomes

$$(1-n)(u u' - K u u' - K' u^2 - u'^2 + u') - K u = 0 \qquad (29)$$

Rearranging Equation (29) in terms of K and K′ results in

$$-K[u + u u'(1-n)] + (1-n)(u u' - u'^2 + u') = (1-n) K' u^2 \qquad (30)$$

Solving Equation (30) for K′ yields

$$K' = \frac{-K[u + u u'(1-n)] + (1-n)(u u' - u'^2 + u')}{(1-n) u^2}$$

$$= \frac{-K}{(1-n) u} - \frac{K u'}{u} + \frac{u'}{u} - \frac{u'^2}{u^2} + \frac{u'}{u^2} \qquad (31)$$

Substituting the value of K in term 2 of Equation (31) yields

$$K' = \frac{-K}{(1-n) u} - \left(\frac{u - u' + 1}{u}\right)\frac{u'}{u} + \frac{u'}{u} - \frac{u'^2}{u^2} + \frac{u'}{u^2}$$

Cancelling terms yields

$$K' = \frac{-K}{u(1-n)} \qquad (32)$$

This is the optimization equation we are seeking but a better form of the equation is a function of x, y and t such that

$$dK = -\frac{K}{1-n}\frac{dv}{u} = \frac{K k_1 dt}{(1-n)}\frac{x}{y} = -\frac{k_2 x}{(1-n) y} dt$$

or

$$\frac{dK}{dt} = -\frac{k_2 x}{(1-n) y} \qquad (33)$$

If we let $R = e^{-1/T}$ and substitute into Equation (7) and (8)

$$K = k_2/k_1 = A_2 R^{B_2}/A_1 R^{B_1} = (A_2/A_1) R^{(B_2 - B_1)}$$

$$dK/dt = (A_2/A_1)(B_2 - B_1) R^{(B_2 - B_1 - 1)} R',$$

where

$$R' = dR/dt$$

Equating the result to Equation (33), we find that

$$(A_2/A_1)(B_2 - B_1) R^{(B_2 - B_1 - 1)} R' = \frac{-k_2 x}{(1-n) y} = \frac{A_2 R^{B_2} x}{(1-n) y} \qquad (34)$$

Now, rearranging Equation (34) gives

$$\frac{R'}{R^{(B_1 + 1)}} = -\frac{A_1 x}{(B_2 - B_1)(1-n) y} \qquad (35)$$

Integrating Equation (35) gives

$$R^{-B_1}\Big|_{T_i}^{T} = \frac{A_1 B_1}{(B_2 - B_1)(1-n)} \int_{t_i}^{t} \frac{x}{y} dt$$

$$-e^{B_1/T_i} + e^{B_1/T} = \frac{A_1 B_1}{(B_2 - B_1)(1-n)} \int_{t_i}^{t} \frac{x}{y} dt$$

If we now let $\frac{A_1 B_1}{(B_2 - B_1)(1-n)} = Q$ and rearrange the result

$$e^{B_1/T} = e^{B_1/T_i} + Q \int_{t_i}^{t} \frac{x}{y} dt$$

Now taking the natural logarithms of both sides, gives

$$T = \frac{B_1}{\ln\left(e^{B_1/T_i} + Q \int_{t_i}^{t} \frac{x}{y} dt\right)}$$

Evaluating Q from the identities given yields

$$Q = \frac{A_1 B_1}{(B_2 - B_1)(1-n)} = \frac{A_1 B_1}{(B_2 - B_1)\left(1 + \frac{B_1}{(B_2 - B_1)}\right)}$$

$$= \frac{A_1 B_1}{B_2}$$

Therefore the final optimizing equation becomes

$$T = \frac{B_1}{\ln\left(e^{B_1/T_i} + \frac{A_1 B_1}{B_2} \int_{t_i}^{t} \frac{x}{y} dt\right)} \qquad (36)$$

The resulting Equation (36) may be solved on a digital or analog computer at a very high rate of speed compared to the speed of reaction. Such a computation will result in the calculation of a correct temperature at all times to yield the final product composition in a minimum time. The principle advantage of this particular method of solving the final optimizing equation is that the process performance is extrapolated from the present operating point to the end point and not from the initial starting point. As a result, the errors in the control function are not accumulative. In fact, there is a strong controlling action tending to force the process to the specified end point despite appreciable discrepancies in the computer equations.

LITERATURE CITED

[1] Eykhoff, Pieter, *IRE Transactions of Automatic Control, AC-5*, No. 2, 148-151 (June 1960).

[2] Ecklund, Karl, *Control Engineering*, 7, No. 4, 161-163 (April 1960).

[3] Smith, K. C., IRE Paper 60AC-14, Joint Automatic Control Conference, Cambridge, Massachusetts, September 7-9, 1960.

[4] Gibson, J. E., *Control Engineering*, 7, No. 10, 109-114 (October 1960).

[5] Goodman, T. P., and Reswick, J. B., *Transactions of the ASME*, 78, 259-271 (1956).

[6] Reswick, J. B., *Control Engineering*, 2, No. 6, 50-57 (June 1955).

[7] Eckman, D. P., Walsh, T. J., Brammer, F. E., and Lefkowitz, I., *Automation Report 1, 1954-1956*, Case Institute of Technology, Cleveland, Ohio, 1956.

[8] Weinstock, Robert, *Calculus of Variations*, McGraw-Hill Book Company, Inc., New York, New York, 1952.

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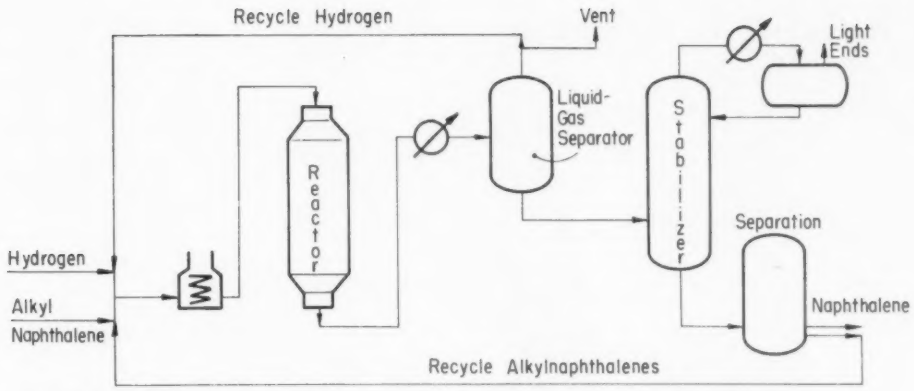

FIGURE 1—Shows the UOP Hydeal process for dealkylation of alkyl naphthalene to produce petronaphthalene.

Trends to Watch in Phthalic Anhydride

New starting materials—petroleum naphthalene and xylenes—plus improved catalysts and processes point to added growth for dibasic acids

Joseph Gordon
Los Angeles

PHTHALIC ANHYDRIDE (PA) producers are looking forward to new raw material supplies from petroleum refiners. A group of refiners, in a petrochemical activity reminiscent of the polyethylene boom, are erecting facilities to recover naphthalene or ortho xylene made in catalytic reformers. Either one of these products is suitable for making phthalic anhydride, which repeatedly has been in short supply.

Moving into the bailiwick of coke-oven by-products, these refiner activities bring cheer not only to the PA producers themselves, but to their hundreds of customers in alkyd resin paints, plasticizers, dyes and many others. For the past dozen years, they've been hampered by the recurring naphthalene shortages, the one now being among the worst. For some time, it has been increasingly evident that the coal tar naphthalene supplies could no longer keep pace with the rising PA demand. Moreover, coal tar naphthalene output is levelling off, and trends in steelmaking technology even point to a possible decline within another ten years. So the entry of refiners at this time is based on something more solid than just the immediate short term demand.

PETROCHEMICALS FOR PA

Ortho Xylene. The boom in new ortho xylene capacity began to roll about two years ago and is still gaining momentum. From an estimated annual capacity of 90 million pounds in 1959, ortho xylene is slated for about 505 million pounds annual capacity by the end of 1961 (See Table 1).

Naphthalene. Commercial recovery of petronaphthalene for the first time is on the way. The first plant of its kind will go on stream by the spring of 1961 at Catlettsburg, Ky. A 75 million pounds per year capacity unit of Ashland Oil & Refining Co., it will use the Hydeal dealkylation process jointly developed with Universal Oil Products (See Figure 1).

Following in rapid succession, are two more refiners each with its own dealkylation version, who aim by the end of 1961 to be recovering petronaphthalene. These two are:

- Sun Oil Company with a plant capacity of 100 million pounds per year at Toledo, Ohio.

- Tidewater-Collier, affiliate of Tidewater Oil and Union Oil, with a combined capacity of 150 million pounds per year at two plants, the first at Delaware City, Del., and the second at Los Angeles. All told, the capacity for both petronaphthalene and ortho xylene by the end of 1961 should equal or exceed 850 million pounds per year (See Figure 2).

Phthalic Anhydride. Hardly had these expansion plans been disclosed, when a rush of PA producer activity quickly developed. The two largest PA producers, Allied Chemical and Monsanto Chemical, each decided to start putting in new PA units for late 1961 completion. Another large producer, and two new producers, are planning for new capacity early in 1962. The roster of PA producers, with plant locations and estimated capacities as of the end of 1961, is listed in Table 2.

This burst of PA expansion on the heels of the new

Trends to Watch in Phthalic Anhydride...

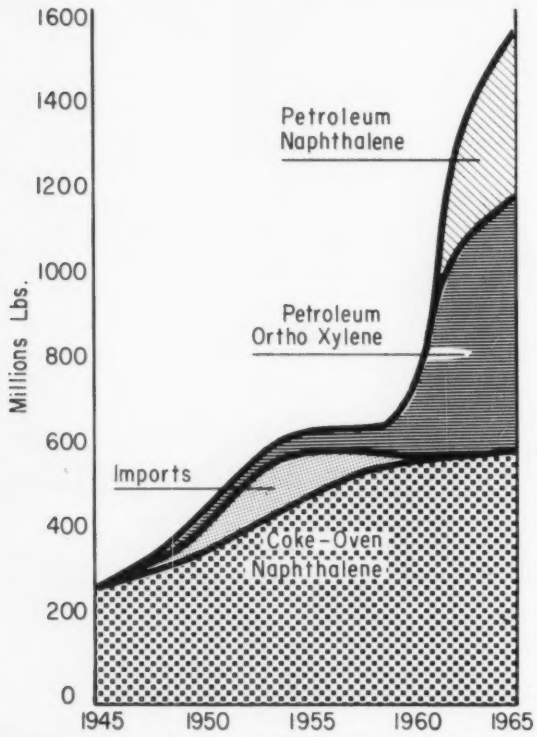

FIGURE 2—As coke-oven and imported naphthalene supplies drop off, petronaphthalene and ortho xylene will dominate the raw material situation for phthalic anhydride.

petroleum-based supply is strong evidence that PA producers have been waiting for it and expect to be using it. In the present acute shortage, most of them are trying to manage on about half their normal allotment. In all probability, they will find themselves even worse off for a while before the improvement begins.

Their current plight is due in large measure to the unusually erratic behavior pattern of the steel industry in the past two years. First there was the slump in 1958, then the steel strike in 1959, and now the extended inventory doldrums in 1960. But if the PA producers can just hold on another few months, the influx of new petroleum supplies coupled with the likelihood of a steel industry comeback should brighten their supply prospects. Their position should then keep improving steadily until the past ups-and-downs are only a memory.

But in anticipating plentiful supplies, PA producers fully realize their other problems won't just disappear. Competition for PA markets is bound to intensify, not only between products, but between domestic and foreign producers. These competitive aspects underscore the need for a) ample materials available at reasonable prices and b) greater efficiency in the PA manufacturing processes.

Most PA producers welcome both the change and the challenge, for having been forced to rely almost entirely on the coke-ovens, they have often felt like pawns in the massive fluctuations of the steel industry. The situation was one in which they had little control. The perennial upshot was, their supply of naphthalene has much of the time been unpredictable and catch-as-catch can.

Looming above the pitfalls of supply fluctuations was the fact that the need for PA was exceeding coke-oven capacity. Since 1945, PA demand has gone up more than fourfold, while the supply of coal tar naphthalene was barely doubling. Ortho xylene was available from time to time, but until 1960 only in very limited amounts, and even so, not entirely satisfactory when used in equipment designed for naphthalene.

NAPHTHALENE IMPORTS

Each passing year brought in new evidence that some relief was needed. One saving feature of the past dozen years has been the European imports, acting as a buffer supply. Both in 1950 and in 1955, two peak production years, imports topped 100 million pounds, amounting to about 25 percent of the total U.S. supply. However, imported quantities were apt to vary widely. In the past year, they have been dwindling away, and from all indications will henceforth remain at a low level. The reason is that the European sources who once were exporting their naphthalene are now selling or using it close to home.

Illustrating the reversal of past trends, producers in Europe as well as in Japan, are arranging to buy the greater part of the new U.S. ortho xylene output. For example, four Japanese trading companies are reported to have signed a three-year contract with Sinclair for 66 million pounds per year. Most of the Cities Service output, marketed by Cosden Petroleum, will go to Japan, and the rest to Europe. European countries are installing facilities to recover ortho xylene and petronaphthalene, and to boost PA production.

Evaporation of this once-essential source is viewed by PA producers with mixed feelings. Probably they wish it could at least held up another year. But for all their assistance, imports have taken no prizes for dependability. During periods of scarcity, import prices had a tendency to skyrocket. Right now for instance (November 1961), some are being quoted at around 15 cents per pound compared to the 6 cents per pound prevailing domestic level.

In times of relative abundance, import naphthalene at U.S. coastal docks was sometimes available at 1-2 cents per pound below the domestic market. However, the apparent savings might well be wiped out by variable quality or delays in delivery. Having to operate in a setting of uncertain supplies and exaggerated price swings, the PA producers kept looking for a way out of this impasse.

NEW SOURCES EMERGE

Their first inkling of an alternate source came about soon after the large-scale advent of xylenes in World War II. A number of refiners, Standard of California among them, were busy with catalytic reforming to make toluene for nitration and for aviation gasoline, obtaining xylenes as a co-product. Eager to get into petrochemicals in the postwar period, Standard was bemused by the commercial potential of the mixture containing the three xylene isomers: ortho, meta, and para.

As a mixture, xylene use seemed limited either to high-octane blending stock or to solvents. Only by separation

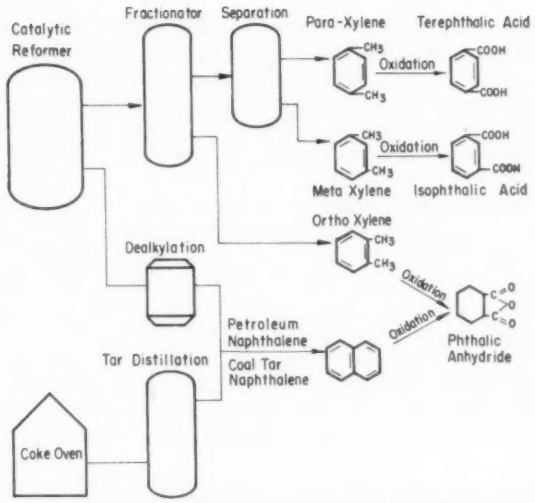

FIGURE 3—Here is the inter-relation of the dibasic acids from various raw material sources showing how petroleum derived naphthalene may soon dominate the phthalic anhydride picture.

could they begin to realize their higher potential value as petrochemicals. One inducement to separate the ortho is that it is the least effective of the three isomers in high-octane blends. But more important, it offered what looked like a feasible alternate route to make PA, for which an established West Coast alkyd resin market would be waiting.

Ortho Xylene. To California Research, Standard's subsidiary, went the difficult task of separating and upgrading the xylenes. Cal Research's program started off with two main objectives:

1. To find out whether the 5.3°C boiling point difference would permit the separation of the ortho isomer by fractionation, with a purity of 90 percent or better. It turned out this could be done, but required some very precise fractionation.

2. To determine the optimum conditions for air-oxidation of ortho exylene to PA, by a fixed-bid process like that used for naphthalene. Exhaustive studies were made of the effects of the important variables: selection and preparation of catalyst; temperature; ratio of air and hydrocarbon; and space velocity.

From its investigation, Cal Research was able to show that the ortho xylene route to PA in a fixed bed is practical: less heat is developed and yields compare quite well with those obtained with naphthalene. Thus encouraged, Standard in 1945 put up a PA-from-xylene unit at its Richmond, Calif., refinery. The plant went on to achieve smooth operation, after overcoming worrisome problems during the shake-down period. Marketed by Oronite Chemical, another Standard subsidiary, this petrochemical PA became a profit-maker.

Other Xylenes. To reap the full benefit from its xylene venture, Standard was hoping that each of the three xylenes would if possible pay its own way. Otherwise the entire cost of separation and development would be borne by the ortho alone. The progress already made spurred research on separating the meta and para xylenes from each other, and on establishing uses for each. As it turned out, the para could be separated and purified by fractional crystallization, the meta by selective sulfonation.

Para Xylene. A ready market was found for the para isomer in the newly developed polyester fibers based on para xylene's oxidation product, terephthalic acid. Production of para xylene was started at Richmond in 1950, expanding in 1953 with Standard's second unit, at the refinery in El Segundo, Calif. Other refiners came into the picture about this time, Humble Oil & Refining, and then Standard of Indiana. Terephthalic markets widened further with the introduction of polyester films. Total annual capacity is now estimated at some 125 million pounds.

Meta Xylene, the most abundant isomer, found the going more uphill in getting established with isophthalic acid, its oxidation product. But in early 1956, Standard went into big-time production with a $10 million plant capable of turning out 50 million pounds per year of this commercially new product. The plant had been

TABLE 1—U.S. Refiners of Ortho Xylene
(Estimated Capacities—End of 1961)

Company	Location	Capacity (Million Lbs./Yr.)
Cities Service	Lake Charles, La.	125
Cosden Petroleum	Big Spring, Tex.	25
Delhi-Taylor	Corpus Christi, Tex.	70
Humble	Baytown, Tex.	75
Oronite	Richmond-El Segundo, Calif.	110
Sinclair	Houston	75
Suntide	Corpus Christi, Tex.	25
	Total	505 Million Lbs./Yr.

TABLE 2—U.S. Producers of Phthalic Anhydride
(Estimated Capacities End of 1961)

Company	Plant Locations	Annual Capacity (Million Lbs./Yr.)	Remarks
Allied Chemical	Philadelphia, Pa. Buffalo, N. Y. Chicago, Ill. Ironton, O. Los Angeles, Calif.	200	*
Monsanto Chemical	St. Louis, Mo. Everett, Mass. Gibbstown, N. J.	160	Fluid*
American Cyanamid	Bridgeville, Pa. (2)	80	1 Fluid
Reichhold Chemicals	Elizabeth, N. J. Detroit, Mich. Azusa, Calif.	70	Fluid
Witco Chemical	Chicago, Ill. Perth Amboy, N.J.	50	
Pittsburgh Coke & Chemical	Neville Island, Pa.	40	
Koppers	Kobuta, Pa.	25	
Oronite	Richmond, Calif.	25	o-xylene
Amoco Chemicals	Joliet, Ill.	15	xylenes
Sherwin-Williams	Chicago, Ill.	7	Fluid
Total		672 Million Lbs/Yr.	

Notes:
*—Probable users of Petronaphthalene in units now building.

scaled up directly from a 100 pounds per day pilot plant unit. By far the largest part of the isophthalic output has been shipped to Eastern markets where it has been finding a niche with growing success in surface coatings and reinforced plastics (See Figure 3).

ACCENT ON PROCESSING

Those making PA from naphthalene eyed these xylene developments with more than casual interest, and naturally speculated on the use of ortho xylene in their own facilities. A few gave it a try during periods of naphthalene scarcity, but the results were rather discouraging. Operating in their usual way, yields fell off some 20 percent, and the process was also reportedly harder on the equipment. Aside from that, there wasn't enough available to help them appreciably, though they kept on using it during shortages to accomodate hard-pressed customers.

Facing the facts, PA producers tried to make the best of their predicament. They took a hard look at the process itself to see where improvements might be made. This proved to be a fertile field for improvement, resulting in refinements and innovations which have greatly altered the process. At the same time, costs have been reduced, and higher yields and better recovery have added some 10 percent or more to the supply.

The key problem—and long-standing bugaboo—in making PA has been that of controlling the temperature, due to the considerable heat generated in the oxidation reaction. At the very minimum, this would come to about 6000 Btu per pound in the case of naphthalene and about 4000 Btu per pound with ortho xylene, assuming the charge stock were 100 percent pure and the product yield 100 percent of theory. But in practice, due to the complete combustion of part of the feed, the heat evolved is more than 50 percent greater. If close temperature control is wanting, the process has a tendency of running away, so that product is lost, impurities increase, and so do the hazards of operation.

Fixed Bed. In the fixed bed process by which most PA is made today, the catalyst is contained in a multiple tube reactor containing several thousand, small-diameter tubes. Thermocouples imbedded throughout the reactor are scanned frequently to detect catalyst "hotspots" and to correct for excessive temperature variations. Heat of reaction is carried off by an externally circulating heat transfer fluid, which might be a special molten salt, boiling mercury, or an organic fluid (See Figure 4).

Fluid Process. A sharply different concept—based on petroleum fluidization processing—began to take shape in the 1940's. At that time, American Cyanamid, a large PA producer, and Sherwin-Williams, a would-be producer, independently pilot planted a fluid bed type of process, using a fluidized, recirculating catalyst. (See Figure 5.) Convinced this new approach had merit, each then went ahead with a commercial unit: Sherwin's of 7 million pounds annual capacity in 1952, and Cyanamid's of 30 million pounds annual capacity in 1956.

Both had considerable trouble getting the process to work right, but are now well pleased. Since then Reichhold Chemical in 1959 went over to the fluid process, and Monsanto's new plant is also going to be a fluid process. Allied Chemical, the largest producer, and several of the others have, so far, stayed with the fixed bed.

The fluid process is claimed to have some important advantages over the fixed bed. These advantages include:

- Savings of around 20 percent in plant investment
- Reductions up to 30 percent in utility and labor costs
- Improvement in yield by 5-10 percent
- Improvement in purity by about 3 percent

Offsetting these, at least in part, are the higher catalyst costs, relatively longer time to reach rated capacity, and higher feed purity required.

Mixed Xylene Oxidation. Still another route to xylene conversion is to oxidize all three as a mixture, then separate the three co-products (See Figure 6). Amoco Chemicals, a division of Standard of Indiana, has put up a plant at Joliet, Ill., to do this in a batch-type, liquid-phase process, using a bromine-catalyzed air oxidation, in the presence of a compound of one

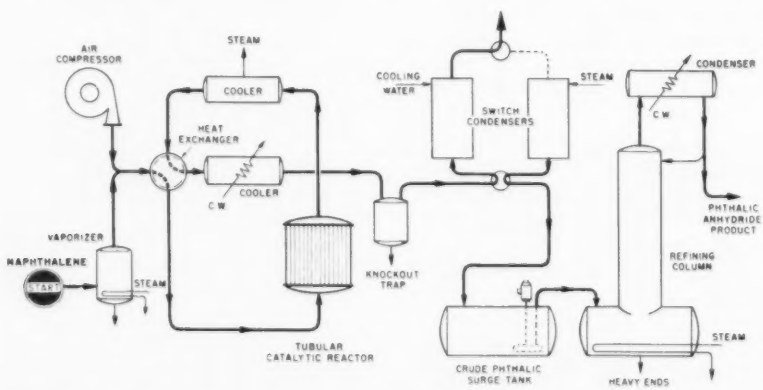

FIGURE 4—This modern fixed-bed phthalic anhydride process features molten salt in the reactor for heat dissipation and switch exchangers for anhydride recovery.

of the heavy metals, such as cobalt. To get the results to jibe with theory, however, has proved a formidable task. Unfortunately for Amoco, its problems were further compounded by a price reduction even before it went into production. As of now, this plant is still below its rated annual capacity of 60 million pounds for PA and the two phthalic acids.

Besides Amoco, a number of other companies, both here and abroad, are reported doing work along similar lines. It might be premature to discount the future potential of the process on the basis of the results thus far. Both the fixed bed and the fluid bed, in their early stages had plenty of problems, and doubtless the first venture into mixed xylene oxidation has also. However, its long-term status is not necessarily affected.

Other Improvements. In two other sectors of this technology, catalysts and product recovery, progress in the past few years has been noteworthy. New compositions and preparation techniques have been developed to make catalysts more selective and to operate at lower temperatures. Both the fluid bed and the fixed bed processes benefit, but especially the latter where the heat problem is more severe. Within the past six months a new catalyst has become available which is claimed to be equally effective for either naphthalene or ortho xylene. This development now enables the maker of PA, regardless of how the supply market shifts, to achieve the maximum operating flexibility.

Progress is further reflected in substantial gains in recovery techniques. Cooling down and collecting the PA in the air-cooled "hay barns" has long been considered costly and inefficient. Modern practice makes use of efficient condensers of large capacity, operated in parallel. By means of a switchover system, while one condenser is used for recovery, the other is heated to melt down previously collected product for subsequent purification. Similarly, catalyst recovery, essential to the economics of the fluid process, has been improved by better disengagement equipment and practice, and by means of filters to help minimize catalyst losses.

Clearly, the entire process technology is undergoing some far-reaching changes. At the present time, the fluid process is demonstrating the most rapid growth. However, neither the fixed bed process nor the mixed xylene liquid phase process should be considered out of the running.

GROWTH AND COMPETITION

The combination of marked improvement in supply outlook and in processing should greatly fortify PA producers for the competition to come. Refiners who will supply a growing share of the needed material, will be affected on two fronts: a) the growth prospects for PA and b) the supply competition with naphthalene from coal tar.

Over-all the outlook for PA adds up to healthy growth, but with some significant changes to be expected. In the two main areas of use—alkyd resins and plasticizers—the former will move forward only slightly, while the latter continues to expand steadily.

Here are some of the prospects:

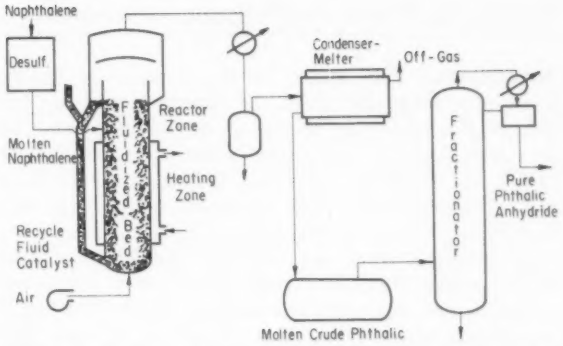

FIGURE 5—Here is a popular version of the fluid bed phthalic anhydride process which features recycled fluid catalyst.

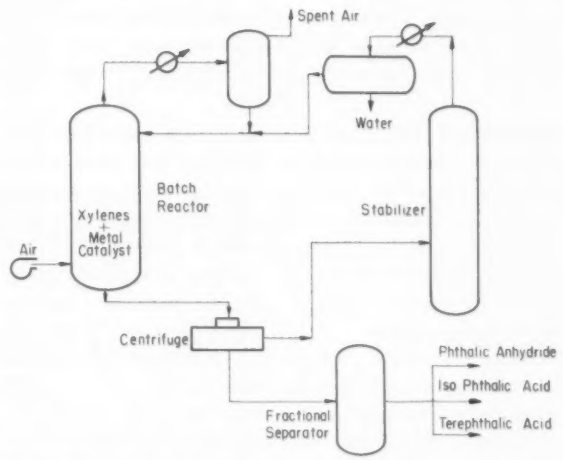

FIGURE 6—In this suggested version of the Amoco Chemicals mixed xylene oxidation process notice the real problem of separation of the mixed acid stream.

Alkyd Resins—For years, this has been the largest single use for PA, going into a multitude of surface coatings for automobiles, appliances, boats, maintenance, and exteriors. Lately, though, many other coatings have become available in large volume, and competition is keen. Some of the other important types are: acrylics, vinyls, epoxies, and the broad category of water-based paints. In addition, a number of modified alkyds have been developed using less PA and more of products such as maleic anhydride, melamines, and the meta xylene oxidation product, isophthalic acid.

In this turbulent situation, where price is a major factor, PA's position is enhanced by the recent processing advances, and the better supply prospects. PA would also stand to gain by the development of water-based alkyds, insofar as they required it in the formulation. According to present indications, a 2-3 percent yearly rate of growth is to be expected in the next five years.

Trends to Watch in Phthalic Anhydride...

Plasticizers. This outlet, in the form of phthalate esters, heretofore has been the second largest use for PA. In the next year or two, it should take over the top spot. Among the phthalates, dioctyl phthalate (DOP) is the most important, but there are perhaps a dozen others with a wide variety of applications. The leading use by far of the phthalates is in plasticizing vinyl resins, in which use they hold nearly 60 percent of the market. On the average, one part of plasticizer is required for two parts of resin, and demand for vinyls should rise some 600 million pounds in the next five years.

Spirited competition is looked for from other plasticizers such as: phosphates, adipates, sebacates, citrates, epoxies, and others. Esters of isophthalic acid may yet provide competition. But phthalates should be able to retain their kingpin role, riding the vinyl boom comfortably with a probable growth of 8 percent per year.

Reinforced Plastics. PA producers entertain high hopes for reinforced plastics, in which their product has a leading part. In the brief span of their commercial existence, reinforced plastics have met many growth obstacles, including misapplications and restriction in building codes. Now they are starting to expand rapidly into such fields as construction, transportation, and industrial equipment.

Total demand at present is around 100 million pounds per year, which by 1965 should reach the 250 million pounds per year level. Ten years hence, reinforced plastics might well break into the billion-pound class, depending in part on building code modernization. Reinforced plastics and plasticizers are therefore expected to be the mainstays of PA growth for the next 5-10 years, while alkyd resins gain relatively little.

As a chemical intermediate, PA shows considerable versatility. Best known are a number of important dyes including the anthraquinones, the rhodamines, and particularly the fast-growing phthalocyanines. Further examples of PA uses includes pharmaceuticals, dielectric materials and decorative laminates. Allyl phthalate should be singled out for attention, and several other products are emerging from the development stage.

Altogether, these trends and prospects auger well for continued PA growth. However, the shifts will bear watching and in most sectors, the influence of price should not be overlooked.

Domestic and Foreign. The next few years are also likely to witness phthalic activity taking on more of an international flavor, with a simultaneous rise in foreign production and foreign trade. Most of the new ortho xylene output is being shipped overseas; ortho xylene recovery facilities are going up in several European countries; and West Germany is building a 100 million pounds per year petronaphthalene recovery unit. Such activities point up the faster pace in foreign production, which is now about on a par with the United States. It signifies a rise in PA imports, in exports of PA and ortho xylene, and an intercontinental race for markets.

Petroleum and Coal Tar. Changing currents in the phthalic situation have both the refiners and the coal-tar naphthalene producers doing some figuring on the relative market prospects for petronaphthalene and ortho xylene versus the naphthalene derived from coke ovens.

Three Points appear applicable in this situation:

1. Material of greater purity will be needed and will be able to command a premium.

2. Coal tar napthalene, a byproduct, will establish the base price.

3. Price differentials will be determined initially by demand, and then by competition.

The coal-tar product for the most part is less pure than that due from petroleum sources. However, some coke-oven operators are modernizing their facilities to turn out a comparable grade. Each coke-oven operator will make his own decision about this, with the result that some will follow through, while others gradually step out. Coke-oven naphthalene will probably continue as the largest U.S. supplier for another 4-5 years. After that, growing demand for PA together with changes in steel-making will probably cause PA producers to look to the refinery for most of their supplies.

Refiners are likely to get a premium for their product because of its higher purity, but strong competitive pressures will act to keep prices down. The initial petronaphthalene output in 1961 is expected to be in the 6-6.5 cents per pound range, dropping back in the next year or two to about 5.5 cents per pound.

Others who enter the arena as PA suppliers will both affect and be affected by the over-all picture. The outlook, though generally favorable, will call for alertness to opportunity rather than complacence. Elements of uncertainty will be reduced by the flexibility of cat reformer operations, as well as by other outlets for the products. Those who do participate will also find that PA producers will be realistic, but mighty appreciative customers. ##

About the Author

Dr. Joseph Gordon is a consultant whose major activity is in chemical market research and development. He specializes in analyzing trends likely to affect the chemical industry with strongest emphasis on petrochemicals. Dr. Gordon's professional experience has been divided almost equally between market research-analysis and technical research and development. This experience includes association with California Research Corp., Monsanto Chemical Co. and General Dynamics Corp. Dr. Gordon received his B.S. in chemical engineering from Washington University (St. Louis) and his Ph.D. in physical chemistry from University of California (Berkeley).

Gordon

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Thermo Data for Petrochemicals

Part 26: You Can Estimate the Gibbs Free Energy of Formation From Group Contributions

H. A. G. Chermin, Central Laboratory
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QUITE OFTEN WE are confronted with the question of whether it is possible to prepare a certain product from given materials. Thermodynamics, which enables a calculation of the position of a chemical equilibrium, can provide an answer to our question. For, the position of the equilibrium determines the direction in which the reaction will proceed. Whether or not the reaction does proceed depends on kinetic factors. In general, a certain amount of activation energy is needed to keep the reaction going. It has been proved in many cases, however, that if the reaction is thermodynamically possible, a catalyst can be found which is sufficiently active and selective to make the reaction proceed.

Stability and Position of the Equilibrium Can Be Calculated. If the reaction of formation of a compound C from its composing elements E_1 and E_2 is

$$n\,E_1 + m\,E_2 \rightarrow C \qquad (1)$$

the equilibrium in reaction (1) is defined by the equilibrium constant:

$$K_f = \frac{[C]}{[E_1]^n\,[E_2]^m} \qquad (2)$$

The relation between the equilibrium constant and the free enthalpy of formation, G, (*Gibbs* free energy) is determined thermodynamically as:

$$\Delta G_f = -R\,T \ln K_f \qquad (3)$$

From (2) it follows that the equilibrium in (1) will shift to the right if $K_f > 1$, and to the left if $K_f < 1$, so that it is clear that the equilibrium in (1) is on the right if ΔG_f in (3) is negative and on the left if ΔG_f is positive. In other words, a compound is stable (with respect to its elements) if at the given temperature $\Delta G_f < 0$. The value of ΔG_f determines the stability of a compound with respect to its component elements.

TABLE 1—The Group Contributions of the Alkanes and Cyclo-Alkanes

$$\Delta G^\circ_f = A + B\ T \ \frac{\text{kcal}}{\text{mole}}\ *$$

Group	300 . . . 600 °K	600 . . . 1500 °K	Correction for	300 . . . 600 °K	600 . . . 1500 °K
CH_4	$-18.719 + 2.180 \cdot 10^{-2}\ T$	$-21.161 + 2.587 \cdot 10^{-2}\ T$	**Branching:**		
$-CH_3$	$-10.833 + 2.176 \cdot 10^{-2}\ T$	$-12.393 + 2.436 \cdot 10^{-2}\ T$	3 Adjacent $-\overset{H}{\underset{\vert}{C}}-$ groups	2.312	2.312
$-CH_2-$	$-5.283 + 2.443 \cdot 10^{-2}\ T$	$-5.913 + 2.548 \cdot 10^{-2}\ T$	Adjacent $-\overset{H}{\underset{\vert}{C}}-$ and $-\overset{\vert}{\underset{\vert}{C}}-$ groups	1.625	1.625
$-\overset{\vert}{\underset{\vert}{C}}H$	$-0.756 + 2.942 \cdot 10^{-2}\ T$	$-0.756 + 2.942 \cdot 10^{-2}\ T$	2 Adjacent $-\overset{\vert}{\underset{\vert}{C}}-$ groups	2.543	2.543
$-\overset{\vert}{\underset{\vert}{C}}-$	$3.060 + 3.636 \cdot 10^{-2}\ T$	$3.840 + 3.506 \cdot 10^{-2}\ T$			
			Ring formation:		
			3 ring	$27.215 - 3.147 \cdot 10^{-2}\ T$	$26.495 - 3.027 \cdot 10^{-2}\ T$
			4 ring	$25.689 - 2.901 \cdot 10^{-2}\ T$	$24.459 - 2.696 \cdot 10^{-2}\ T$
			5 ring	$5.511 - 2.583 \cdot 10^{-2}\ T$	$3.417 - 2.234 \cdot 10^{-2}\ T$
			6 ring	$-0.707 - 1.623 \cdot 10^{-2}\ T$	$-1.145 - 1.550 \cdot 10^{-2}\ T$
			Ring-branching:		
			5 ring		
			Single branching	$-0.665 - 0.065 \cdot 10^{-2}\ T$	$-0.443 - 0.102 \cdot 10^{-2}\ T$
			Double branching:		
			1.1 position	$-1.880 - 0.138 \cdot 10^{-2}\ T$	$-1.112 - 0.266 \cdot 10^{-2}\ T$
			cis 1.2 position	$-1.485 + 0.245 \cdot 10^{-2}\ T$	$0.939 - 0.159 \cdot 10^{-2}\ T$
			trans 1.2 position	$-2.163 - 0.138 \cdot 10^{-2}\ T$	$-1.377 - 0.269 \cdot 10^{-2}\ T$
			cis 1.3 position	-1.423	$-0.637 - 0.131 \cdot 10^{-2}\ T$
			trans 1.3 position	$-1.888 - 0.138 \cdot 10^{-2}\ T$	$-1.048 - 0.278 \cdot 10^{-2}\ T$
			6 ring		
			Single branching	$-0.370 - 0.106 \cdot 10^{-2}\ T$	$0.452 - 0.243 \cdot 10^{-2}\ T$
			Double branching:		
			1.1 position	-1.722	$-0.432 - 0.215 \cdot 10^{-2}\ T$
			cis 1.2 position	-0.500	$1.432 - 0.322 \cdot 10^{-2}\ T$
			trans 1.2 position	$-2.003 - 0.138 \cdot 10^{-2}\ T$	$-0.173 - 0.443 \cdot 10^{-2}\ T$
			cis 1.3 position	-3.055	$-1.687 - 0.228 \cdot 10^{-2}\ T$
			trans 1.3 position	-1.718	$0.262 - 0.330 \cdot 10^{-2}\ T$
			cis 1.4 position	-1.152	$-0.192 \cdot 10^{-2}\ T$
			trans 1.4 position	$-3.125 + 0.034 \cdot 10^{-2}\ T$	$-1.205 - 0.286 \cdot 10^{-2}\ T$

* To retain internal consistency the values in this table are given to more decimal places than is justified by the accuracy of the correlation.

TABLE 2—The Group Contributions of the Alkenes, Cyclo-Alkenes and Alkynes

$$\Delta G^\circ_f = A + B\ T \ \frac{\text{kcal}}{\text{mole}}\ *$$

Group	300 . . . 600 °K	600 . . . 1500 °K	Correction for:	300 . . . 600 °K	600 . . . 1500 °K
$H_2C = CH_2$	$11.653 + 1.552 \cdot 10^{-2}\ T$	$9.451 + 1\,889 \cdot 10^{-2}\ T$	**Ring formation:**		
$H_2C = CH$	$14.281 + 1.642 \cdot 10^{-2}\ T$	$13.513 + 1\,770 \cdot 10^{-2}\ T$	Pentene ring	$3.455 - 2.448 \cdot 10^{-2}\ T$	$2.189 - 2.237 \cdot 10^{-2}\ T$
$H_2C = C<$	$16.823 + 1.864 \cdot 10^{-2}\ T$	$15.785 + 2.037 \cdot 10^{-2}\ T$	Hexene ring	$-1.043 - 2.070 \cdot 10^{-2}\ T$	$-0.737 - 2.121 \cdot 10^{-2}\ T$
$HC = CH$ (cis)	$18.407 + 1.834 \cdot 10^{-2}\ T$	$16.781 + 2.114 \cdot 10^{-2}\ T$			
$HC = CH$ (trans)	$17.019 + 2.007 \cdot 10^{-2}\ T$	$16.755 + 2.051 \cdot 10^{-2}\ T$			
$HC = C<$	$20.273 + 2.306 \cdot 10^{-2}\ T$	$19.913 + 2.366 \cdot 10^{-2}\ T$			
$>C = C<$	$23.955 + 2.839 \cdot 10^{-2}\ T$	$25.731 + 2.543 \cdot 10^{-2}\ T$			
$H_2C = C = CH_2$	$45.293 + 1.010 \cdot 10^{-2}\ T$	$43.439 + 1.319 \cdot 10^{-2}\ T$			
$H_2C = C = CH$	$48.871 + 1.063 \cdot 10^{-2}\ T$	$48.133 + 1.186 \cdot 10^{-2}\ T$			
$H_2C = C = C<$	$51.159 + 1.481 \cdot 10^{-2}\ T$	$51.159 + 1.481 \cdot 10^{-2}\ T$			
$HC = C = C<$	$53.176 + 1.528 \cdot 10^{-2}\ T$	$52.690 + 1.609 \cdot 10^{-2}\ T$			
Conjugated alkenes					
$H_2C \leftrightarrow$	$9.634 + 1.088 \cdot 10^{-2}\ T$	$8.980 + 1.197 \cdot 10^{-2}\ T$			
$\leftrightarrow C \leftrightarrow$	$3.100 + 0.610 \cdot 10^{-2}\ T$	$2.536 + 0.704 \cdot 10^{-2}\ T$			
$-C \leftrightarrow$	$12.302 + 1.438 \cdot 10^{-2}\ T$	$12.408 + 1.420 \cdot 10^{-2}\ T$			
$\leftrightarrow \overset{\vert}{C} \leftrightarrow$	$5.280 + 0.994 \cdot 10^{-2}\ T$	$5.634 + 0.935 \cdot 10^{-2}\ T$			
Alkynes					
$HC \equiv$	$27.104 - 0.775 \cdot 10^{-2}\ T$	$26.678 - 0.704 \cdot 10^{-2}\ T$			
$-C \equiv$	$27.478 - 0.617 \cdot 10^{-2}\ T$	$27.346 - 0.595 \cdot 10^{-2}\ T$			

* To retain internal consistency the values in this table are given to more decimal places than is justified by the accuracy of the correlation.

The equilibrium of the reaction:

$$C + D \rightarrow P + Q \qquad (4)$$

is determined by the constant:

$$K_{eq} = \frac{[P]\ [Q]}{[C]\ [D]} \qquad (5)$$

The relation between this constant and the change in the free enthalpy owing to the reaction is given by:

$$\Delta G_{reaction} = -R\ T \ln K_{eq} \qquad (6)$$

where, as can be checked in a simple way from equations (1), (2) and (3):

TABLE 3—The Group Contributions of the Aromatics

$$\Delta G_f^\circ = A + B\,T \left(\frac{\text{kcal}}{\text{mole}}\right)^*$$

GROUP	300—600° K	600—1500° K	Correction for:	300—600° K	600—1500° K
HC	$3.100 + 0.610 \cdot 10^{-2}\,T$	$2.536 + 0.704 \cdot 10^{-2}\,T$	**Branching**		
–C	$5.280 + 0.994 \cdot 10^{-2}\,T$	$5.634 + 0.935 \cdot 10^{-2}\,T$	**Double branching:**		
			1.2 position	$0.955 + 0.055 \cdot 10^{-2}\,T$	$1.687 - 0.067 \cdot 10^{-2}\,T$
			1.3 position	$0.352 - 0.057 \cdot 10^{-2}\,T$	$0.574 - 0.094 \cdot 10^{-2}\,T$
–C	$2.260 + 0.553 \cdot 10^{-2}\,T$	$2.566 + 0.502 \cdot 10^{-2}\,T$	1.4 position	$-0.183 + 0.105 \cdot 10^{-2}\,T$	$0.615 - 0.028 \cdot 10^{-2}\,T$
			Triple branching:		
			1.2.3 position	$1.453 - 0.112 \cdot 10^{-2}\,T$	$1.039 - 0.043 \cdot 10^{-2}\,T$
			1.2.4 position	$0.297 - 0.070 \cdot 10^{-2}\,T$	$0.243 - 0.061 \cdot 10^{-2}\,T$
			1.3.5 position	$-0.320 - 0.137 \cdot 10^{-2}\,T$	$-0.436 - 0.116 \cdot 10^{-2}\,T$
			Quadruple branching:		
			1.2.3.4 position	$3.664 - 0.007 \cdot 10^{-2}\,T$	$4.456 - 0.139 \cdot 10^{-2}\,T$
			1.2.3.5 position	$2.861 + 0.025 \cdot 10^{-2}\,T$	$3.359 - 0.058 \cdot 10^{-2}\,T$
			1.2.4.5 position	$2.736 - 0.150 \cdot 10^{-2}\,T$	$3.072 - 0.206 \cdot 10^{-2}\,T$
			Quintuple branching	$4.400 + 0.091 \cdot 10^{-2}\,T$	$5.468 - 0.087 \cdot 10^{-2}\,T$
			Sextuple branching	$8.254 + 0.260 \cdot 10^{-2}\,T$	$10.006 - 0.032 \cdot 10^{-2}\,T$

* To retain internal consistency the values in this table are given to more decimal places than is justified by the accuracy of the correlation.

$$\Delta G_{\text{reaction}} = \Delta G_{fP} + \Delta G_{fQ} - (\Delta G_{fC} + \Delta G_{fD}) \qquad (7)$$

It follows that, if the free enthalpies of formation of the compounds taking part in the reaction are known, the position of the equilibrium in this reaction can be calculated in a simple way.

If, therefore, a compound is to be synthesized in a given way, it is necessary to determine in what range of temperature and pressure the $\Delta G_{\text{reaction}}$ of the proposed process is *zero* or *negative,* in order that a catalyst may be found which can be used in these ranges of temperature and pressure. If these ranges cannot be determined for a given synthesis method, it is in most cases recommendable to find a different method for preparing the desired compound.

From what has been said above it follows that knowledge of the numerical values of the free enthalpies of formation of the compounds is of great importance.

Thermodynamic Properties of Gaseous Organic Compounds Are Related to Molecular Structure. Only a small portion of the large number of organic compounds has been examined for their thermodynamic behavior, and it is improbable that the thermodynamic properties of all these compounds will ever be measured exactly. Therefore, it is important that studies have been and are being made to find suitable methods for calculating these properties.

Theoretically, the properties can be calculated by a statistico-mechanical method. This method is very laborious, however, and in most cases the spectroscopic data needed for it are not available. Recently excellent work was done in this field under the API research project No. 44 (see e.g., the particularly good summary concerning this work).[1]

Methods for calculating thermodynamic properties from as few data as possible have long been searched for. A survey of this work is given in the excellent and critical compilation made by Janz.[2]

Some years ago Van Krevelen and Chermin published a method[3,4] by which a rapid and simple calculation can be made of the free enthalpy of formation of organic compounds in the ideal gaseous state. More recent data, and the fact that the correlation given at the time has a less elegant side, form the reason why a completely revised method was developed.

This new method also based on the assumption that the free enthalpy of formation of an organic compound is given by:

$$\Delta G_{f_{\text{com}}} = \sum \begin{matrix}\text{contribution of}\\ \text{component groups}\end{matrix} + \sum \begin{matrix}\text{corrections,}\\ \text{if necessary}\end{matrix} + R\,T \ln \sigma \qquad (8)$$

where $R\,T \ln \sigma$ is the symmetry correction.* For a motivation of formula (8) the reader is referred to the work of Janz.[2]

The group contributions and corrections as functions of temperature are defined by a relation of the shape:

$$\Delta G_{f\ \begin{matrix}\text{group or}\\ \text{correction}\end{matrix}} = A + BT \qquad (9)$$

Relation (9) is supported by a calculation given by Scheffer.[5] It has appeared impossible, however, to describe the whole temperature range (300 . . . 1500°K) by one linear temperature function. The interval was therefore split up into two parts (300 . . . 600°K and 600 . . . 1500°K) in which it *was* possible to describe the free enthalpy of formation by relation (9).

Equation (9) bears a very close resemblance to the general formula:

$$\Delta G_f = \Delta H_f - \Delta S_f T \qquad (10)$$

in which ΔH_f and ΔS_f are functions of temperature. Obviously, A and B may therefore be identified with the mean value of the enthalpy of formation (heat of formation) and the entropy of formation, respectively, in the temperature range under consideration. Comparisons have shown that A is a good approximation of the mean enthalpy of formation of the compound in the temperature range under consideration.

The group contributions of the hydrocarbon groups

* The *symmetry number* is the number of indistinguishable positions in space the molecule may be made to take up by a simple rigid rotation. The symmetry number of a molecule may be found by considering a space model of the molecule concerned. A large amount of symmetry numbers is given in Herzberg's book.[6]

are given in tables 1, 2 and 3. These were calculated from the compilation[1] mentioned above, supplemented by data on cyclopropane,[6] cyclobutane,[7] alkyl benzenes,[8] and napthalene.[9] The group contributions shown in tables 1, 2 and 3 have been chosen so that they describe the numerical data given in literature as well as possible.

For non-hydrocarbons no group contributions are given here, since it is impossible at the moment to calculate reliable contributions for these substances with the help of literature data on ΔG_f values (with the possible exception of sulfur compounds). For, as a rule only the thermodynamic properties of the first few terms of the homologous series of these compounds are known, and these terms, as is well known, show a behavior differing from the additive behavior of the higher terms.

How to Calculate ΔG_f. In order to give a clear idea of this method the free enthalpy of formation of 2-methyl naphthalene will here be calculated by way of example. (In drawing up the correlation no use was made of the thermodynamic data for 2-methyl naphthalene.)

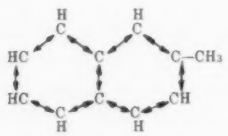

	Table No.	300 . . . 600 °K		600 . . . 1500 °K
$7\,\Delta G°_{f\ HC\leftrightarrows}$	3	= 21.700 + 4.270 · 10^{-2} T	=	17.752 + 4.928 · 10^{-2} T
$1\,\Delta G°_{f\text{-}C\leftrightarrows}$	3	= 5.280 + 0.994 · 10^{-2} T	=	5.634 + 0.935 · 10^{-2} T
$2\,\Delta G°_{f\ C\leftrightarrows}$	3	= 4.520 + 1.106 · 10^{-2} T	=	5.132 + 1.004 · 10^{-2} T
$1\,\Delta G°_{f\text{-}CH_3}$	1	= − 10.833 + 2.176 · 10^{-2} T	=	− 12.393 + 2.436 · 10^{-2} T
RT ln σ (σ = 1)		= 0.000 · 10^{-2} T		0.000 · 10^{-2} T +
$\Delta G°_f$ (2-methylnaphth.)		= 20.667 + 8.546 · 10^{-2} T	=	16.125 + 9.303 · 10^{-2} T

Temp. °K	300	600	1000	1500
$\Delta G°_f$ calc.	46.31	71.94	109.16	155.67
$\Delta G°_f$ * lit.	46.25	71.96	108.99	155.88

Temp. °K		300—600	600—1500
$\Delta H°_f$ calc.	(mean)	20.67	16.13
$\Delta H°_f$ lit.	(mean)*	19.69	15.88

* The literature values were calculated using the thermodynamic functions given by **Milligan, and Pitzer** [10], the heat of combustion given by **Richardson and Parks**[11], and the heat of evaporation given by **Dreisbach**[12].

How Accurate Is the Correlation? The correlation was checked on 200 gaseous hydrocarbons in the temperature range 300 . . . 1500°K. More than 1,000 points of comparison were used, and it appeared that the mean deviation was about $\pm 0.6 \frac{\text{kcal}}{\text{mole}}$. Only in very rare cases was the deviation as high as $2 \frac{\text{kcal}}{\text{mole}}$, which we therefore considered its maximum value.

LITERATURE CITED

[1] F. D. Rossini, K. S. Pitzer, R. L. Arnett, R. M. Braun and G. C. Pimentel. *Selected Values of Physical and Thermodynamic Properties of Hydrocarbons and Related Compounds*, Carnegie Press, Pittsburgh (1953).

[2] G. J. Janz. *Estimation of Thermodynamic Properties of Organic Compounds*, Academic Press, New York (1958).

[3] D. W. van Krevelen and H. A. G. Chermin. *De Ingenieur* 62, Ch 65 (1950).

[4] D. W. van Krevelen and H. A. G. Chermin. *Chemical Engineering Science* 1, 66 (1951).

[5] F. E. C. Scheffer. *Application of Thermodynamics to Chemical Processes* (in Dutch), Waltman, Delft (1945).

[6] G. B. Kistiakowsky and W. W. Rice. *Journal of Chemical Physics* 8, 618 (1940)

[7] G. W. Rathjens, N. K. Freeman, W. D. Gwinn and K. S. Pitzer. *Journal of the American Chemical Society* 75, 5634 (1953).

[8] S. H. Hastings and D. E. Nicholson. *Journal of Physical Chemistry* 61, 730 (1957).

[9] A. L. McClellan and G. C. Pimentel. *Journal of Chemical Physics* 23, 245 (1955).

[10] D. E. Milligan, E. D. Becker and K. S. Pitzer. *Journal of the American Chemical Society* 78, 2707 (1956).

[11] J. W. Richardson and G. S. Parks. *Journal of the American Chemical Society* 61, 3543 (1939).

[12] R. R. Dreisbach. "Physical Properties of Chemical Compounds," Am. Chem. Soc., Washington (1955).

NOMENCLATURE

C, D, P, Q, etc. = compounds
E_1, E_2 = elements
K_f = equilibrium constant for formation from the elements
K_{eq} = equilibrium constant
A and B = constants
ΔG_f = free enthalpy of formation (Gibbs free energy of formation)
$\Delta G°_f$ = free enthalpy of formation in the ideal gaseous state at a fugacity of 1 atm
$\Delta G_{reaction}$ = free enthalpy change as a result of the reaction
R = gas constant
T = absolute temperature
σ = symmetry number
$\Delta H°_f$ = enthalpy (heat) of formation
ΔS_f = entropy of formation

About the Author

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H. A. G. Chermin

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HOW TO DESTROY THE 'UGLY AMERICAN'

FIGURE 1—Executives exchange ideas on a problem assigned by BCIU, thus getting solid experience.

People in other nations have been seeing a distorted, one-sided and unlikable picture of foreign-based American businessmen. Now a revolutionary new school is helping overseas personnel learn how to show the other side of the coin

Kerryn King
Texaco Inc.

MANY PEOPLE overseas regard Americans with distrust. They are semi-villains—not particularly liked—frequently misunderstood—often unwanted.

Since the end of World War II, as our involvement and responsibilities in foreign areas have grown, some American business executives have found this so in their dealings with foreign nationals.

Formation of BCIU. Since the fall of 1959, American executives enrolled in an intensive four-week course conducted by the Business Council for International Understanding (BCIU), at The American University in Washington, D. C., have been working to improve the American image. The course is de-

FIGURE 2—Wives join group for briefing and discussion during final week of BCIU's Training Program for international business executives. Here, they informally cover important points. This "close-out" session helps crystallize key problem areas.

signed to do something about the need for better preparation of Americans involved in foreign business relations. The program acquaints businessmen with social, political, and other conditions in countries where they will work. It also tries to help them better interpret the U.S. and understand people in foreign countries—to see how their views differ or coincide with those of Americans, and why.

Representatives of both the State Department and the United States Information Agency often lead discussions during the run of the course. They make themselves available for consultation with businessmen who want more detailed information about their areas.

Views of a Statesman. One of the most well-informed BCIU speakers is Douglas Dillon, former Under Secretary of State. Recently, in an address delivered at Williams College, he said:

"Private American business and other groups are also recognizing the need to prepare their representatives for work abroad. Many of them run their own company or institutional programs. Others send their people to our universities. Recently, leading executives of U.S. companies doing business overseas established the Business Council for International Understanding . . . This program fills two closely related needs: First, to send overseas individuals who are better prepared to make a success of their assignment for their companies; and, second, to build goodwill for the United States . . . It . . . holds out great promise—for the private sector of our economy is the very antithesis of the state enterprise that is central to Communist doctrine. It is perforce the very best advertisement of freedom at work . . ."

Many more examples of freedom at work are needed to combat the organized Communist propaganda attacks that come from behind the Iron Curtain. Because of this threat, a key development in U.S. foreign policy in recent years has been the growing impact of free enterprise in international diplomacy. All over the free world—in underdeveloped areas and in countries with long-established industrial economies—public money and private money have been working together as never before.

The Postwar Boom. At the end of the war, the United States began assuming unaccustomed international responsibilities—both political and economic. At the same time, American business began a new and rapid expansion overseas, in response to economic opportunity and necessity.

As America became more involved in the internal affairs of nations abroad, both government and industry were rudely awakened. They awoke to the complexity of their problems and relationships in some foreign areas. This, of course, was not true in every case. There are tens of thousands of American businessmen ably representing their companies in nearly every free-world country.

With few exceptions, these businessmen in foreign countries go about their day-to-day duties honestly, diligently, fairly, and with best intentions. It takes a lot of capital and courage to strike out into new areas far from the home office. Many of our large corporations which have the capital and courage have made important friendships overseas.

These friendships not only benefit the company, but reflect great credit on our country's way of life. They are the kind of achievements that a diplomat, no matter how capable, cannot hope to duplicate. They are also the kind of achievements that go unnoticed, for the most part.

Unhappily, it is usually the exception that makes the headlines. Some businessmen, either through naivete or laxness, operate with aloofness. These men display a parochial North American outlook that disregards local customs and problems. They often believe that because they are citizens of the United States they are well-liked automatically.

In either case, frictions that ignorance or indifference can create may prove irreparable. In certain foreign areas such practices can destroy good will that other companies have spent years building up.

A Case in Point. Take the case of an American steel company operating in Mexico, for example. When the time came to dedicate the company's new plant, the firm made an advance announcement to the New York press to get what it considered necessary newspaper coverage. A plane-load of New York reporters were flown to Mexico City to attend the ceremonies. They were wined, dined, and finally flown home. Then, sometime later, someone happened to remember the Mexican press.

Invitations were quickly typewritten and mailed to representatives of the Mexican press, asking them to attend another dedication ceremony. To the company's chagrin, not one was accepted. Understandably, the Mexican newspapermen felt snubbed at not being invited along with the American reporters, and let it be known that their dignity had been affronted. The plant, after all, was in Mexico, but the company had chosen to all but ignore its Mexican interests.

Often, companies go about their business in foreign countries just as they would have done at home—with best intentions. They seem unaware that different circumstances call for different handling and different methods.

The Time Element. Take the matter of time, for example. To Americans, time is money. But to millions of people—particularly among the Middle East countries and the Orient—it is nothing of the sort. In some countries, what would amount to a 10-minute business transaction in America may require hours of preparatory small talk or even an elaborate banquet. In the United States, businessmen probably take care of numerous such transactions over the telephone every day.

In certain areas, mistakes by American businessmen may jeopardize the delicately balanced diplomatic position of the United States there. In the light of recent world events, it seems hardly necessary to stress the need for American representatives to constantly demonstrate understanding and friendship toward their host countries.

Foreign attitudes toward us can weaken or strengthen the position of government and business abroad. Because of this, former President Eisenhower in 1955 asked a key group of corporate and government leaders to meet and decide what actions industry might take to help remove misconceptions abroad and help build positive understanding. One result of this meeting was the organization of BCIU. Four years later came the introduction of its Training Program

FIGURE 3—Chats with women who have returned from abroad give wives tips on adjusting to the "foreign" environment.

FIGURE 4—Basic conversation necessities are covered in language courses, a valuable BCIU tool.

for International Business Executives.

In the fall of 1959, the BCIU's Training Program, administered through The American University's School of International Service, was begun to strengthen company foreign operations. The program was developed by the BCIU Committee on Training, headed by Texaco Board Chairman Augustus C. Long—also a member of the Council's Policy Board.

Under the chairmanship of Charles M. White, chairman, Republic Steel Corp., the BCIU Policy Board membership now includes top executives from 24 leading U.S. corporations that have big capital investments abroad.

The Vice President Speaks. The wisdom of former President Eisenhower's request was underlined by former Vice President Richard M. Nixon, who experienced violent anti-American demonstrations throughout his tour of Latin America in 1958. At a luncheon held shortly after his return, where the nucleus of the BCIU Policy Board was formed, the vice president warned, "If we are to meet effectively the total effort the Communists are making in the non-military area . . . our efforts must be total . . . this means not only government, diplomatic, military, and economic teamwork, but it means that the great private segment in our economy—which in many cases, makes the major impact abroad—must take the major share of this responsibility."

The responsibility Mr. Nixon spoke of is a great one. A wave of nationalism is sweeping through many foreign countries. Open distrust, new and restrictive governmental regulations, and increasing social obligations face American enterprises overseas.

With the possible exception of Western Europe, a growing number of foreign governments have shown willingness to risk economic chaos under nationalism rather than continue ventures supported by American capital and technical skill. Often this attitude is due to Communist activity. The Kremlin is always ready to support a nationalistic group in its battle for "freedom" against capitalistic oppressors." But too often the attitude is due to American inactivity —or indifference.

How to Stifle Apathy. It is this stigma of inactivity or indifference that the BCIU Training Program hopes to remove. The four-week BCIU course (an optional two-week intensified language study is available for executives whose language needs must go beyond basic conversational necessities) is based on the assumption that five elements—in addition to technical competence—are important in preparing executives to take their place overseas:

- First, the ability to quickly, skillfully, and affirmatively understand the people of other countries.
- Second, the ability to interpret many aspects of American economics and culture, particularly those elements in American life which are often misunderstood or misinterpreted abroad.
- Third, an elementary speaking knowledge of the country's language. The more fluent the better.
- Fourth, a practical concept of actual business, social, and domestic situations that are likely to be encountered in various countries.
- Finally, during the last week of

the course, the wives of the executives join the group. They hold sessions on family life, social relations, and household management in a foreign setting. An important point often overlooked is that a community-conscious, courteous, and adaptable wife may well be an international executive's most valuable asset.

These five broad objectives form the groundwork of the program's operations. The responsibility of interpreting them into a workable curriculum lies with Training Program Director Harold M. Randall. He is a former career U.S. Foreign Service Officer and U.S. representative to and chairman of the Inter-American Economic and Social Council of the Organization of American States with Ambassador rank. Mr. Randall works directly with Dr. Ernest S. Griffith, dean of The American University School of International Service.

Enrollment Policy. Although five courses are scheduled annually, enrollment is limited to 25 executives for each course. This enables each trainee to receive careful, personalized guidance. The course is especially for administrative, technical, and advisory executives preparing for international assignments at home and abroad. Several participating companies bring home the most promising of their foreign-based executives to take it.

Quite a few companies also bring managers of their various foreign operations (who frequently are nationals of those countries) to the United States. They are put through the course, and sent back better equipped to assume higher echelon positions later.

BCIU feels that effective management of international business operations is achieved through analysis of the political, economic, and social practices of other countries. Thus, the course helps executives improve knowledge of the customs and language of the country with which they will deal.

At the same time, these businessmen learn much about their own country, too. Executives are briefed on American history and hear expert observations on foreign assessment of the United States. They study our foreign policy, the image of America abroad, and the U.S. Mutual Security Program. They are told of current trends in international communism; listen to talks on American civilization, and discussions of cultural relations, communications, and sociological change.

Specialized Curriculum. Since participants work in groups geared to the area of their prospective assignment or special interest, a separate curriculum is offered for each of the following areas: Latin America, Western Europe, Middle East, Far East, and South and Southeast Asia. A special curriculum is made up to cover certain specialized areas, such as Australia, Africa (south of the Sahara), and countries like the Philippines or Israel which differ markedly from others in the area.

The special program offered to wives, whose attitudes and behavior can greatly influence the success of their husbands' work in foreign areas, is held during the course's final week. Wives are given orientation talks that cover a variety of subjects with which they will have to deal. They learn why the program is needed; discuss American foreign policy; analyze cultural differences around the world; improve their knowledge of American institutions—political, social, economic, and cultural.

Through invitations to some of Washington's many international gatherings, the wives learn something of the role of an international hostess. Chats with women who have returned from abroad, or who are familiar with the areas to which they will be going, give them valuable tips on how to establish a household, make social contacts, entertain, and contribute to community life.

Obviously, the BCIU program cannot give a man and his wife answers to all the problems they will encounter while working and living overseas. What it attempts to do is start them thinking in the manner of the foreigners with whom they will be dealing. As one participant put it, in his evaluation of the program at the completion of the course, "This training has really started us talking the language, both literally and figuratively, of those with whom we must deal overseas. It could mean the end of the overseas misfit."

With annual enrollment limited to 150 executives, the BCIU program can fill only a small part of the business community's need for broader understanding of international affairs. But a start has been made, and there are others. The annual Maxwell Institute on American Overseas Operations at Syracuse University, and the Foreign Trade School at Phoenix, Arizona, are examples. At the graduate student level, there are several others such as the language and area study centers at Johns Hopkins and Stanford Universities.

At a time when the nations of the free world are rebelling against every form of colonialism, there is no room for the bumbling businessman, government official, tourist, or any other representative of the United States on the foreign scene.

This is a cause of the utmost importance both to the individual company—whose stake in the ultimate outcome is growing larger every day—and to the nation as a whole. It is certainly something that deserves the active support and constructive participation of every serious-minded executive. After all, it is our own future that hangs in the balance. ##

About the Author

King

Kerryn King is vice president and assistant to the chairman of the board of Texaco Inc. Holder of a B.S. degree in journalism from Southern Methodist University, he joined Texas Power and Light Co., Dallas, in 1939 as assistant to the vice president. In 1942 he went with Consolidated Vultee Aircraft Corp.'s Public Relations Department, Fort Worth. In 1943 he joined Hill and Knowlton, Inc., New York public relations counsel, became a vice president in 1947, and senior vice president in 1952. Mr. King joined Texaco as director of public relations in 1953. He was appointed assistant general manager of the Employe and Public Relations Department in June, 1957, general manager three months later, and was elected vice president in charge of that department in 1958. In 1960 he assumed his present position.

RAPID READING 1

You Can Learn to Read Better, Faster

If you want to improve your personal efficiency—if you want to read faster and understand more—then you'll be interested in the techniques presented in this new series

Nila B. Smith
The Reading Institute, New York University
New York City

TODAY, THERE is an entirely new reading methodology that has arisen to aid adults in meeting the demands of our times. This has been necessary because never before in our history has there been so much reading to do. Never before has there been so little time in which to do it.

Thousands of newspapers, hundreds of magazines, dozens of books roll from the press daily. Every man is confronted with mountains of memos, correspondence, reports, and he never quite clears them up until another avalanche descends upon him. Yet all of these items that require reading must be respected because these days to lead one *must* read. And we all aspire to leadership.

What is the answer? Not more time in which to read, but the ability to read more in the time we have. We need to develop a new reading tempo to gear in with the pace of the space age.

In order to meet this need which adults throughout the country are feeling a new art has arisen, a new art of reading which enables the reader to get more out of what he reads in a shorter time. The purpose of this article and the one that follows in the next issue is to acquaint you with some of the newer techniques, and to tell you how you can apply them in your own reading whether it be for business or for pleasure.

SOME GENERAL POINTERS

First of all it will be heartening for you to know that it is easy for an adult to improve his reading ability. The reading skills yield readily to the right treatment and practice. I have come in contact with the records of hundreds of people who have taken a course in reading improvement. Their gains are surprising and gratifying.

Even though improvement comes readily, you need to realize that reading is a composite made up of dozens of different skills. You can't expect to make much in the way of gains if you approach reading ability as a "lump sum." You need to concentrate on one ability at a time until you are pretty good at using it, then gradually combine abilities in different ways as they serve your purposes.

Practice Is Necessary. Furthermore, you must realize that there is no trick or magic about learning to read faster and better. Reading makes use of skills just as piano-playing or skating or golf depend upon the use of skills. Instruction and practice are basic essentials in any skill development program. When you begin to play golf an instructor tells you what the different clubs are for and shows you how to make the strokes. Highly developed ability, however, comes only through continuous practice in using the clubs and making the strokes in the right way.

So it is with reading skills. In these two articles you will learn the use of some of the different "clubs" and how to "make the strokes." But it's up to *you* to do the practicing. As a reader of technical and semi-technical material in connection with the hydrocarbon processing industry you must definitely resolve to tackle your reading improvement program in the

same way that you would tackle skill development in any other area. Desire, determination, instruction, practice—these are the basic ingredients in your recipe for reading improvement. Once you've put yourself in the right frame of mind, you've made a good start.

With these general considerations in mind, we shall now discuss some of the specific reading skills and suggest "Do it yourself" techniques for you to use in streamlining your own reading ability.

INCREASING SPEED

Your first interest probably is to learn to read more rapidly. Here are some of the "secrets" of speed reading.

1. Set a Purpose. In increasing your speed, and in fact in developing all of the other skills discussed in this article, decide upon your purpose for reading a selection *before* you start to read it. Is it to get information that would be helpful in your work? To find out about a new process which might make a contribution to your plant? To gather news about what others are doing? To find out how to improve your personal efficiency? To be entertained by some light reading? To follow the plot of a story? Or what?

Phrase your purpose concisely, and keep it uppermost in your mind throughout the reading of the entire selection. A well defined purpose pulls your eyes along more rapidly, and it gives you something to tie to in selecting and organizing ideas gathered from the text. In fact your purpose is the pilot which guides you over the sea of print and leaves you with a well-filled dragnet of ideas at the end of your reading journey.

2. Grasp Groups Of Words. Investigations of eye-movements have shown that the rapid reader's eyes move fleetingly across the lines, pausing briefly two or three times on each line, picking up an "eyeful" of words at each pause, while the eyes of the poor reader pause on every word or on small word units. It is the mind, of course, that controls the eye-movements. The great value of eye-movement investigations is that they furnish us a picture of the different ways in which the mind works in perceiving reading symbols. They tell us that the mind of the poor reader loafs along, picking up very small units at a time, while the eyes of the excellent reader race over the lines, gathering an entire, meaningful idea at a glance.

Cultivating the habit of reading for *ideas* not only increases speed, but it also increases understanding. A person who reads one word at a time thinks in terms of the meanings of these separate words and thus he "can't see the woods for the trees." The synthesis of important meanings is lost in any meticulous perception of the meanings of separate words or small units.

The first and most important instruction is, "Read for Ideas!" If you can cultivate the habit of rapidly picking up one complete thought unit after another, the eye movements will take care of themselves.

Try grasping fairly long groups of words, each of which presents a complete idea, in reading the rest of this article; then in all of the reading that you do.

3. Force Speed. Perhaps you've fallen into the habit of reading in a slow tempo. Maybe you developed a rate that was comfortable for you while you were in the elementary grades and have done nothing about changing it all through your life. You **can** change it though. You have a comfortable, habitual rate of walking but you **can** walk faster when you want to. So you can read faster if you try. Shake yourself out of the old lethargy. Force your speed: make yourself read faster—faster than you ever have read before. Consciously push your eyes across the lines as fast as you can make them go and still know what you are reading about. Across, back, across, back, across, back, in rapid rhythmic sweeps. Just make those eyes leap over the lines. They are your servants. You can control them. Don't let them loaf along in the old lazy way.

Forcing yourself to read faster will take effort at first. It won't be as comfortable as the old rate. But after a time you will become accustomed to the rapid tempo, and new patterns of rate will become firmly established. You will then read fast unconsciously and just as a matter of habit.

4. Application. Now you have some information on how to increase your speed. But information alone won't do the job. You will need to practice, practice, practice. Set aside stated periods of time for practice—perhaps half-an-hour each evening. Choose easy selections while you are breaking the old tempo. Set an alarm clock to go off three minutes hence. Force your speed in taking in long, meaningful groups of words. Stop when the alarm rings. Count the number of words you have read. Divide by 3 and that will give you your W.P.M. (words per minute) score.

Check your understanding, also. Speed without comprehension is useless. After each trial, get someone to question you on the content of what you have read; or try to tell yourself the gist of the selection, and check your accuracy by referring to the text, itself.

In addition to the specific periods in which you work on speed, force yourself to read faster everything that you have to read all day. Try the same techniques described in this article on *everything* you read. Regardless of whether you are reading memos or ads that are piled up on your desk, news items, magazine articles or chapters in books, push your eyes along as fast as you can make them go, grasping large groups of words, and accelerating your mental process in rapidly picking up meanings.

PREVIEWING

An exceedingly useful technique to the man in industry or business is that of *previewing* a selection before reading it.

There is a basic reason why we "window shop" before buying a garment or a car or a new gadget. We want to "size up" certain characteristics of articles in which we are interested as a whole. If it's a coat, we first evaluate it in terms of material and color. Then we look at the style of the garment, and note the cut of the collar and the flare of the cuffs. No doubt, we compare this piece of merchandise with others in price. In short, we gather as much information as possible about characteristics which are important to us before we actually buy. Likewise, it is possible and advisable to glean as much information as we can about an article, a chapter or a book before we read it.

In some cases the preview will provide you with all the information that you desire and you won't find it necessary to read the selection at all. In other cases the preview will "whet your appetite," increase your interest and strengthen your personal motive for reading. In these latter cases when you actually do begin to read the

selection, you will find that your pre-reading insight has paved the way for speedier and more comprehensive coverage of the printed page.

Here are some techniques to use in previewing your reading matter.

1. Study the Title. The first step to take always is to study the title. The title holds a world of information for you. It tells you concisely what the selection is about. It gives you a quick cue as to the topic of discussion. It may be a deciding factor in determining whether or not you want to read the selection. If you decide that you do want to read, then you have advance information in regard to the subject discussed and can read in terms of the promise that the title holds out to you.

As an example of this technique, consider the title of this article, LEARN TO READ BETTER, FASTER. In examining this title you know before you read the article that its subject is *reading*. You know that it will tell you something about *learning* to read. Of course, you know how to read already, but you may be interested in the promise of learning to read "better, faster."

In longer titles there usually is one key word that gives you a clue in regard to the precise aspect of the subject discussed. Consider some titles from previous issues of PETROLEUM REFINER. One title was "Cut Foundation Costs for New Tanks." Studying this title reveals that the article is not about "new tanks" in general, nor about "foundation costs" in general. The key word is "cut." The article promises to tell you how to *cut* foundation costs for new tanks.

Another title: "How to Design Heat Exchanger Piping." In examining this title you are not led to believe that you are going to read about heat exchanger pipes in general. You are given a key word that sharpens up the general topic and confines it to one particular aspect of heat exchanger piping. That key word is *design*.

In studying any title think about the general topic but also find the key word which gives you a clue in regard to the specific nature of the discussion.

2. Examine Visual Aids. If any visual aids are furnished, next turn your attention to them, and study these visual aids for their meaning significance. Illustrations may accompany the selection. If so, look at them carefully. They will aid your comprehension by giving you a vivid mental picture of the people, things and locale dealt with in the context. If maps are provided, study them. Your reading will be more meaningful if you have precise geographical locations in mind. Often graphs and charts are provided. If so, study these carefully before you read the article. They will give you a quick grasp of relationships and proportions amongst data which will be discussed in the text.

Men working in the hydrocarbon processing industry frequently encounter charts and flow diagrams in their reading. The REFINER, for instance, always contains many drawings carefully labeled and each accompanied with a clear explanation. In reading this magazine or any material in which charts, graphs, flow diagram, etc., appear, study all of them *before* you read. Then when you do read, you will have a much clearer understanding of the processes which the drawings try to visualize for you.

3. Glance at the Subheads. Next, glance through the selection to see if subheads are used. If so, you will find that a quick survey of these subheadings will be very valuable to you. You should consider each one for the information which it actually gives or which it implies. These subheads are the major topics in the author's outline. They reveal to you the heads of discourse in the structure of the article as a whole.

As an example of the use of this technique, glance at the boldface subheads up to this point in this article. Did not this glance at subheads alone tell you what topics would be treated? Furthermore, did not the numbered subheads under "increasing speed" tell you what techniques to use in accomplishing this skill? In other words you could have gotten the gist of this article up to this point, simply by studying the title and glacing at the subheads.

There will be many occasions in which a preview of subtitles will tell you all you want to know. At other times they will serve as interest-leads to reading the different sections, and as door-openers to better understanding of the text that follows.

4. Notice Paragraph Length. As another step, examine the length of the paragraps. Turn the pages quickly and find out if most of the paragraphs are short, medium or long. Remember, each paragraph is a thought unit. One idea is developed in each one of them. If there are many short paragraphs this is fairly reliable indication that the article will not be heavy with detailed ideas. On the other hand, if the paragraphs are long then there will be fewer main ideas, but each main idea will be expanded by numerous details. So, on the whole, this will be more difficult reading.

Finally, after you have done all of these things, make an estimate of how long it will take you to read the article. Count the words in a few lines to find the average number of words per line. Then multiply this number by the number of lines in the article. Once you have estimated the total number of words in the article, decide how long it should take you to read it. Don't be easy with yourself. Set as short a time limit as you think you can possibly meet. Then live up to it!

CRACKING THE PARAGRAPH

Can you "crack" the paragraph quickly and accurately? In other words can you break through the outer shell of a paragraph and get to the "kernel" at once? This is an extremely valuable skill and one that is subject to almost unlimited development. It is especially useful when working with paragraphs containing long sentences and dense with ideas. Such paragraphs make for difficult reading unless you know how to tackle them. If you can immediately locate the "heart" of a long, detailed paragraph, the supporting ideas seem to fall in line quite easily and naturally.

When you toss a pebble into a pool of water, you immediately perceive a circular ripple at the spot where the pebble came into contact with the water. Then other concentric circles appear, one after the other until there is an entire set of circular ripples. So it is with a paragraph. Figuratively speaking, the author tosses one main idea into a paragraph which sets all the other ideas in motion. It is your job to learn how to find this pivotal idea, swiftly and surely.

Main Idea Technique. In much of the reading that you do you won't care to take time to consider all of

the details. You will be satisfied if you can speedily glean the main ideas in the selection. Expertness in "spotting" the basic thought in each paragraph is the skill that you need to cultivate.

On the other hand, some selections will be of such significance, that you will want to read and consider the minor ideas carefully. Then you will find that locating the main idea in each paragraph is of major importance because the central thought provides you with a core around which you can organize the details. Whether you are doing cursory reading for the purpose of gathering the larger ideas, or whether you are doing detailed reading for exact information, you will find it to your advantage to acquire the technique of reading paragraphs. In order to do this, however, you must develop a systematic approach rather than just following along one sentence after the other without effort or thought in regard to paragraph organization.

Position and Wording Vary. The position of the key sentence in a paragraph varies. Often the germ idea appears in the first sentence. If so, this is a convenience to the reader because he doesn't have to search through the entire paragraph for the central thought. At other times, the important idea occurs in the middle, at the end, or somewhere else in the paragraph. Because of the variance in the location of the key sentence within a paragraph, position is not a reliable guide in finding the main idea. You must learn surer ways of locating the one basic thought.

Furthermore, the main idea may appear as a complete sentence in itself, or in a few words within a sentence which may express the basic thought. Quickly finding and grasping the main idea regardless of where or how it appears is one of the fine arts of reading.

Finding Main Ideas. The first thing to do is to develop a new attitude toward paragraph reading—the attitude of thinking of each paragraph as a unit. As you encounter a new paragraph, view it as if it were all the reading material you had before you at the moment. Decide what is the one important idea this paragraph has to impart.

Read the paragraph below. Find and underline the sentence or part of a sentence that gives the gist of the whole paragraph unit.

"Coke removal is hydraulic, using 2,400 psig water. A single pump is used for cutting water, but each drum is provided with a separate drill stem assembly. The hydraulic cutting system and procedure is essentially the same as that previously described for American's El Dorado coker."[1]

If you underlined "Coke removal is hydraulic" you made the right selection. That is the most important thought in the entire paragraph. The additional ideas expressed simply elaborate upon this one basic thought.

Find and underline the main idea in this paragraph:

"A few words of caution should be injected at this point. The complex fluid flow and heat transfer phenomena occurring in reboilers are not yet completely understood. A great deal of research is being devoted toward better understanding, but certain empirical correlations will be necessary for many years to come. Any unified procedure which is directed toward practical plant design or operation runs the risk of over-simplification in the mind of the designer. It is hoped that the reader will keep this thought before him as he follows the developments of this article."[2]

Did you underline the second sentence? Then you were right. And it takes every word in this sentence to convey the important idea.

Try another one. Find and underline the main idea in this paragraph:

"Among engineers and plant operators there's a lot of talk about today's heavy oils—they're not what they used to be. Some of this is just old-fashioned griping, but we also find more than a grain of fact. Heavy oils have been made less easy to use. This is due to changes in refining methods. The newer methods aimed at improving yield and quality of gasoline, and light fuel oils have affected the by-product heavy oils and caused them to be less easy to use than the straight-run residuals of years past. So you see there is some substance back of all this talk about oils not being what they used to be."[3]

Were you fooled by the first sentence? The most important idea is not that ". . . there's a lot of talk about today's heavy oils." The really important statement in the paragraph is the one made in the last sentence," ". . . there is some substance back of all this talk about oils not being what they used to be."

Application to Daily Reading. You have been given some basic instruction and practice in the art of reading paragraphs. You have been launched on the technique of finding the main idea accurately and quickly. The extent to which you perfect this skill depends on you. You may sharpen this tool to a very fine point by continuing to use it every time you have occasion to read. Special practice periods are of course highly desirable as well.

From this time on, in all your reading, both informal and special practice, do three things:

1. Force your speed
2. Take a preview
3. Apply paragraph-reading techniques.

Keep a record of your speed and comprehension in each of your practice periods. You should begin to note substantial gains.

LITERTURE CITED

[1] Meyer, D. B., and Webb, J. C. "Coker Can Handle High Carbon Stock." PETROLEUM REFINER, Vol. 39, No. 2, (February 1960), p. 157.

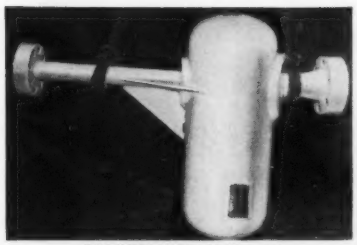
[2] Fair, James R. "What You Need to Design Thermosyphon Reboilers," PETROLEUM REFINER, Vol. 39, No. 2, (February 1960), p. 105.

[3] Weber, A. J. "You Need to Know How and Why Study Fouls Up Fuel Oil Systems," *Power*, September 1954, p. 109.

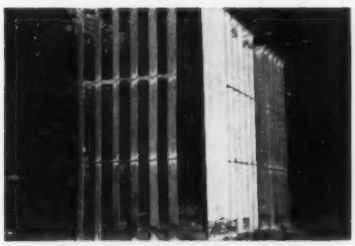
TO BE CONTINUED

About the Author

Dr. Nila Banton Smith is professor of education at New York University where she is director of the reading institute and head of the graduate teacher training programs in remedial reading. She is recognized as one of the leading reading authorities in the country, having authored 16 textbooks, one trade book and more than 200 magazine articles on that subject. A native of Michigan, Dr. Smith received her B.A. degree from the University of Chicago, and her M.A. and Ph.D. degrees from Columbia University. Previous to joining NYU, Dr. Smith was teacher and supervisor of reading in the Detroit public schools, associate professor at Indiana University and professor at the University of Southern California. She is a member of numerous professional societies, and rates her reading speed at about 1,200 words a minute.



GAS PRESSURE, 1500 p.s.i.



SPECIAL ALLOY STEEL DEFLECTORS

TOWER, 8'6" dia. x 154' in length

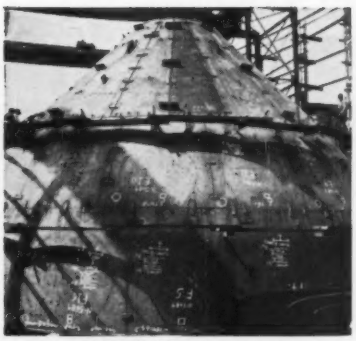
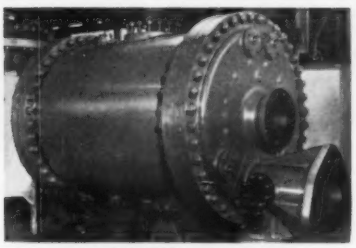
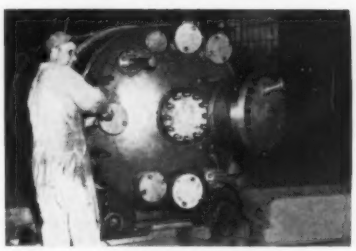


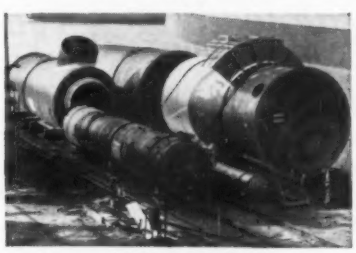
PLATE WORK, 55' dia. cone



SPECIAL CHEMICAL VESSEL



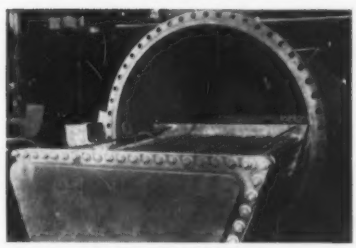
STAINLESS AUTOCLAVE



WATER SHIPMENT

GALVANIZING POT

SPECIAL STAINLESS VESSELS



SPECIAL CONDENSER

MACHINERY PARTS

MADE TO ORDER EQUIPMENT FOR OIL REFINING & CHEMICAL PLANTS

We place at your disposal one of the largest and most thoroughly equipped plants of its kind, featuring advanced production methods with experienced personnel in all departments.

PRODUCTS—Towers, Stills, Condensers—Kilns, Heat Exchangers, Pressure Vessels, Plate Work—All Codes, Any Material, Special Machinery, Machine Work.

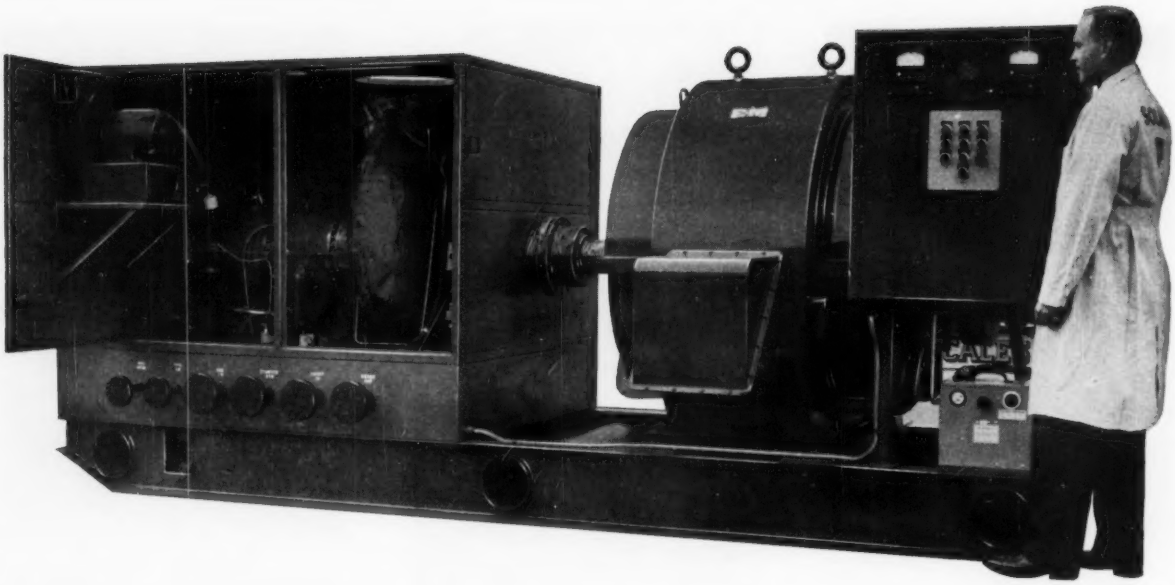
SPECIAL SERVICES—X-Ray Equipment—Stress Relieving Furnaces.

SHOPS—Boiler, Welding, Machine, Fabricating, Pipe, Blacksmith, Anglesmith, Sheet Metal, Copper, Separate Stainless Shop.

WATER AND RAIL SHIPMENTS—Our plant, including crane for loading and handling is located on the Delaware River with piers and deepwater to accommodate sea-going ships and railroad connections to all points.

SUN SHIPBUILDING & DRY DOCK COMPANY

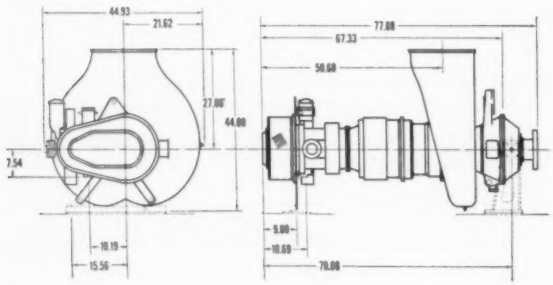
CHESTER, PA.



800 KW!

Solar industrial gas turbine generator sets ideal for peak loading or constant duty

Versatile, compact industrial generator sets powered by Solar's T-1000 gas turbine engine have a nominal rating of 800 kw. They are ideal for either peak loading or constant duty electrical power applications. Simple design and rugged construction reduces maintenance



to a minimum. Installation is extremely simple. The engine is about 1/10th as heavy as diesel units of similar horsepower and occupies only 51 cu ft. No elaborate foundation or flooring base is required because the gas turbine is practically vibration-free.

Equipped with one of the several control systems available, the engine can be operated remotely and entirely automatically. It starts instantly and operates at full load without warmup, even after long periods of standby service.

Fuel economy of the Solar T-1000 engine is unmatched in its field. The engine runs equally well on a variety of fuels including gasoline, diesel fuel and natural gas. The exhaust may be used in a waste heat boiler or as combustion air in process apparatus or conventional boilers.

Cost of this gas turbine is competitive with diesel engines in many industrial applications. For further information on Solar's turbine-powered generator sets, its complete line of gas turbine engines or industrial compressors, write to Dept. H-203, Solar Aircraft Company, San Diego 12, California.

SOLAR

A subsidiary of International Harvester Company

Test Yourself on Labor Relations

No. 1. Layoff for Efficiency?

After a long study of its operations management concluded a realignment of jobs was necessary. It called the union in and told of its decision to improve efficiency. This meant the elimination of five jobs—a cut in the work force by 25 employes—and assignment of additional duties to the remaining workers. The union objected. It argued:

1. You cannot take unilateral action on so drastic a change. This calls for negotiation.
2. The fact that you called us in to tell us about this implies we should play a part in the final decision.
3. By assigning additional duties to other workers, you are overloading them. Work loads are subject to negotiation.

The company position was:

1. We have a clause in our contract that says the union will cooperate with management to "the advancement of conditions looking forward to a profitable operation." Your attitude doesn't sound like "cooperation".
2. We have a duty to improve efficiency.
3. If, after we have installed the new duties, employes feel they are being overworked, we can take that issue up later.
4. We called you in as a courtesy. We want to get along and believe in giving you advance information on our plans. This does not compel us to negotiate.

Test Yourself:

Was the company: Right ☐ Wrong ☐

No. 2. Holiday Pay During Layoff?

Because of poor business a number of employes were laid off. Two months later they were recalled. During the layoff two holidays came up. The company policy was to pay for these provided the workers showed up the day before and after. Management had been paying for a holiday if an employe was laid off that week—but not for workers on longer layoffs. When the employes came back after the two-month layoff, they claimed pay for the two holidays. Their arguments:

1. When we were on layoff we were still "employes", covered for all benefits.
2. We didn't come to work the day before and day after the holiday because we were on layoff. So this provision does not apply to us.

The company answered.

1. A person on layoff is not a real employe. He is not subject to "direction and control of the employer".
2. Nothing in our policy calls for holiday pay for employes on layoff.
3. What if employes are on *permanent* layoff? Do they keep on collecting holiday pay?

Test Yourself:

Was the company: Right ☐ Wrong ☐

No. 3. Does Hangover Justify Discipline?

When George didn't show up for overtime work, Supervisor Coombs got into his car to look for a substitute. A mile from the plant he saw George driving to work—red-eyed, sleepy looking, and "appearing as though he had had a big night". The foreman told George to "go home". He didn't. He went into the plant. When told he wouldn't be put on the job because he had a hangover, he insisted he was all right, and finally left.

He came back to work the next day and was on the job for a week when he was fired for coming to work intoxicated. In its argument the company made no distinction between a hangover and intoxication. It said in either state the employe was not fit to work, and if allowed to go to his job might hurt himself or someone else. The employe admitted taking a few too many the night before but insisted he was okay in the morning. Discharge, he said, was far too severe.

Test Yourself:

Was the employe: Right ☐ Wrong ☐

Answers on Next Page

HIGH-PRESSURE FLOWS

BROOKS CAN METER THEM AS HIGH AS 100,000 PSI! Brooks rotameters work well under pressure. Right now there are several operating around the clock at 40,000 psi, in process lines ranging from ½ to 2 inches. Operation has been very satisfactory. Even on heavily pulsating flows. (The meters have built-in provision for pulsation damping. It is simple. And very effective.) ■ Brooks high-pressure meters can be supplied with either electric or pneumatic transmitting extensions. Both are compatible with most receiving instruments. Both use the Brooks magnetic position converter, the most reliable transducer of its kind. ■ If you have a high-pressure metering job, ask us about it. We can probably give you exactly what you need. And at a price somewhat lower than you'd expect to pay. Design Specification Sheet 3613 will give you more information.

BROOKS INSTRUMENT CO., INC.
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Brooks Instrument Canada Limited, Scarborough, Canada • Brooks Instrument Company, S. A., Fribourg, Switzerland • Brooks Instrument Nederland, N. V., Veenendaal, Netherlands

SA 2360

Test Yourself

(Answers to Quiz on Page 161)

CASE NO. 1

A Board Of Arbitrators ruled: "The first point to be decided is management's right to make such changes in job duties as it feels necessary for successful operation. It is inherent in collective bargaining agreements that management may make normal adjustments in employe assignments. Elimination of jobs, changes in the size of the work force, and assignment of new tasks is within the terms of 'operation of the plant and direction of the working force'. Management may change or eliminate job classifications in the interest of economy and efficiency—unless this right is specifically restricted by the collective-bargaining agreement. This contract does not restrict management in this regard. Management's action is within its rights. Grievance denied."

CASE NO. 2

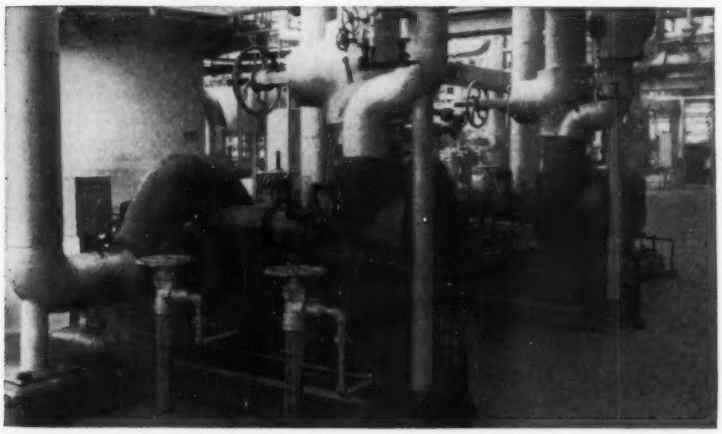
Arbitrator Saul Tischler ruled: "Paid holidays are a standard feature of nearly all collective-bargaining contracts. Payment for unworked holidays tend to better morale of the worker and maintain a harmonious employer-employe relationship. Many arbitrators have allowed holiday pay to those on layoff for a REASONABLE time. Reasonable time is a relative and flexible term. Considering the type of business involved, its seasonal nature, and a review of the facts, we find that any employe on a layoff for less than 90 days shall be entitled to a holiday allowance. Beyond that would be UNREASONABLE time. In this instance the employes were on layoff for less than 90 days and therefore are entitled the holiday pay."

CASE NO. 3

Arbitrator George D. Bonebroke ruled: "The worker was allowed to come back to work, and discharged a week later. This indicated that the employer did not consider him an undesirable employe. The penalty was too severe in view of absence of proof that he had been drinking that morning. Also, George had a good record. However, disciplinary suspension is merited. An employe who comes to work with a hangover is not fit for his job. A 10-day suspension is imposed."

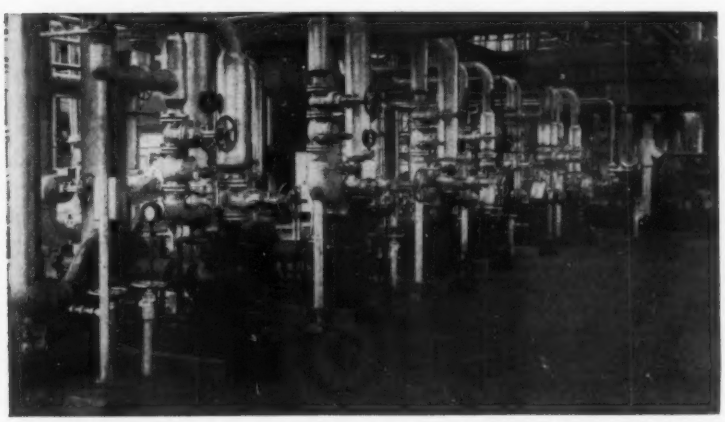
For more data on advertised products, use Readers' Service Cards, last page.

80 Wilson-Snyder ES Centrifugal Process Pumps help keep Texaco's new Puget Sound Works on stream!



Shown are heavily lagged Wilson-Snyder 2 x 3, 2-stage ES pumps handling hydrocarbons at 183 gpm and 902-feet differential head. Wilson-Snyder pumps of other sizes are available for similar services with capacities from 15 to 2000 gpm.

Ten Wilson-Snyder Pumps are in Texaco's new polymerization plant in the Puget Sound Works, the largest being the 3 x 4 x 8½ ES shown in front. Pumps in this plant handle fluids of varying specific gravities under a wide range of temperatures and pressures and have capacities from 40-400 gpm.



This installation is at the crude unit. Eleven Wilson-Snyder Pumps, both steam turbine and motor driven are in service here handling fluids with temperatures up to 691 °F. at capacities from 15 to 515 gpm.

80 Wilson-Snyder Pumps in 11 different sizes have been installed in Texaco's new, modern refinery at Anacortes, Washington. They will perform under a wide range of temperatures, capacities, specific gravities and pressures.

In spite of the varied types of service conditions, the 80 pumps do not require a large stock of maintenance parts. All 11 pump sizes can be serviced with only *three* sizes of bearing bracket assemblies, including shafts, sleeves, bearings and packing. What's more, nine other Wilson-Snyder pump sizes can also be serviced from these same three bearing bracket assembly sizes.

This interchangeability of parts means low inventory investment for overall maintenance. You, too, can save money by standardizing on Wilson-Snyder Process Pumps for all requirements within the scope of their application.

Wilson-Snyder Process Pumps are designed for applications up to 900°F., suction pressures to 600 psi, and discharge pressures to 750 psi. They are furnished in 20 sizes from 15 to 2,000 gpm, 50 to 1,100 foot head, and 2 to 250 horsepower.

USS, "Oilwell" and Wilson-Snyder are trademarks

Convenient Application Advice

. . . on Wilson-Snyder Process Pumps can be arranged through your nearest "Oilwell" Branch . . . or direct from WILSON-SNYDER SALES ENGINEERS at . . . Chicago, Illinois . . . Dallas, Texas . . . Houston, Texas . . . Los Angeles, California . . . New York, N. Y. . . . Tulsa, Oklahoma . . . Pittsburgh, Pa.

USS Wilson-Snyder Works
Oil Well Supply
Division of
United States Steel

For more data on advertised products, use Readers' Service Cards, last page.

How to Do It...

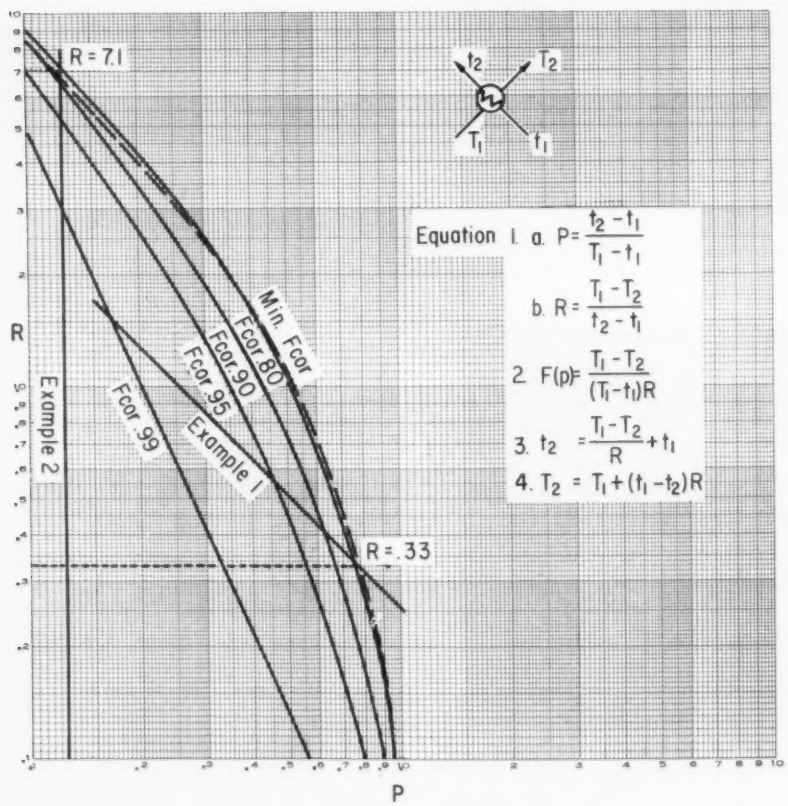
TEMA Trial-and-Error Method Shortened

Nomograph used to cut time in finding exchanger outlet temperatures

Using the data in Equation 1 and the charts in TEMA, 4th Edition, requires a trial-and-error method to find the outlet-shell or tube temperatures. However, the trial and error method can be eliminated by noting that the relationship between P, the temperature efficiency, and R, the temperature change ratio is that shown in Equation 2 which is a rectangular hyperbola. When plotted on log-log paper, the hyperbola becomes a straight line with a slope of minus one.

On the figure are curves which represent plots of TEMA's F_{cor} charts with P as the abscissa and R as the ordinate and F_{cor} value of 0.8, 0.9 0.95 and 0.99.

When the known or fixed-inlet-shell, inlet-tube and outlet-shell temperatures are substituted into $F_{(P)}$, it can be drawn on the figure by letting $R = 1$ and passing a straight line with a slope of minus one through P and $R = 1$. The value at the intersection of the 0.8 F_{cor} curve and the $F_{(P)}$ line is then substituted into Equation 3. The final outlet-tube temperature is thereby determined without the trial and error method. The outlet-shell temperature can also be found when the remaining temperatures are fixed. Equations 1(a) and 4 are used and the outlet-shell temperature is thereby determined without the trial and error method.



Example 1. Find the outlet-tube temperature t_2 of a single-shell and multi-tube pass heat exchanger if the inlet-shell temperature $T_1 = 60°$ C, the inlet-tube temperature $t_1 = 20°$ C and the outlet-shell temperature T_2 is 50° C. The F_{cor} must be equal to 0.8 or greater. No other information is known.

Substitute into Equation 2 the known facts:

$$F_{(P)} = \frac{T_1 - T_2}{(T_1 - t_1)R} = \frac{60 - 50}{(60 - 20)R}$$

$$F_{(P)} = \frac{10}{40R} = \frac{.25}{R}$$

Let $R = 1$; therefore $F_{(P)} = .25$.

Draw a straight line with a slope of minus one through the point $P = .25$ and $R = 1$ on the chart.

$R = .33$ from the intersection of $F_{cor} = 0.8$ and the line just drawn.

Substituting $R = .33$ into Equation 3.

$$t_2 = \frac{T_1 - T_2}{R} + t_1$$

$$t_2 = \frac{60 - 50}{.33} + 20 = 30 + 20$$

$$t_2 = 50° \text{ C}$$

Example 2. Find the outlet-shell temperature (T_2) of a single-shell and multi-tube pass heat exchanger if the inlet-shell temperature (T_1) is 70° C, the inlet-tube temperature (t_1) is 30° C and the outlet-tube temperature (t_2) is 35° C. The F_{cor} must be equal to or greater than 0.8. No other data is known.

Substitute into Equation 1(a) the known data:

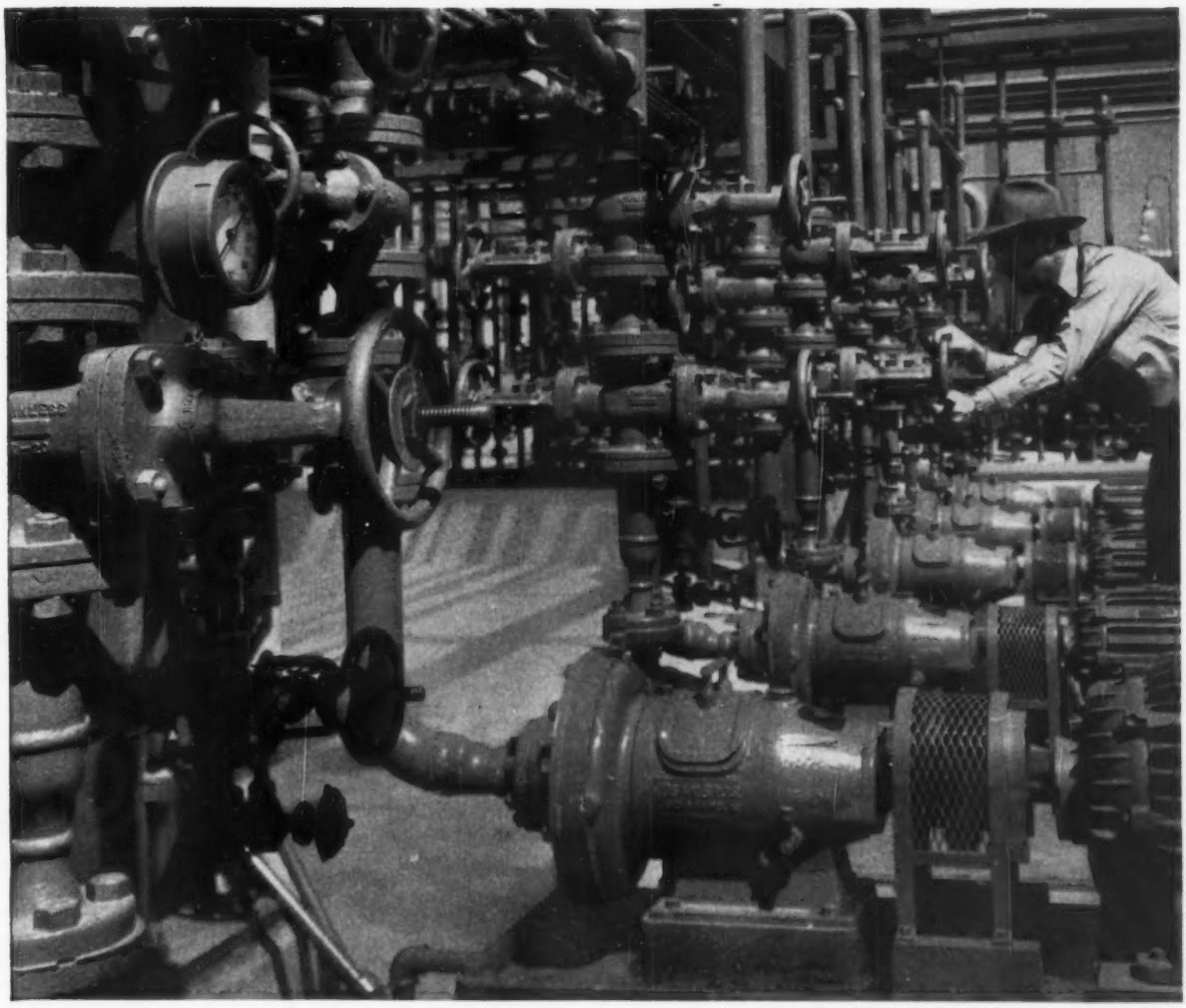
$$P = \frac{t_2 - t_1}{T_1 - t_1}$$

$$P = \frac{35 - 30}{70 - 30} = \frac{5}{40} = .125$$

$R = 7.1$ at the intersection of the $F_{cor} = 0.8$ curve and $P = 0.125$.

Substitute $R = 7.1$ into Equation 4 with the known data:

$$T_2 = T_1 + (t_1 - t_2)R$$



Ni-Resist irons: best "life insurance" yet for pump parts that live with H_2SO_4

Impellers cast from Ni-Resist* iron mean longer life for these pumps – moving a daily volume of concentrated sulfuric acid.

Maybe sulfuric acid isn't your problem. But if acids, alkalis or corrosive waters threaten your equipment, Ni-Resist irons may provide your answer.

With their high Nickel content and austenitic structure, Ni-Resist irons offer a unique combination of advantages:

They resist corrosion and erosion from high-velocity flow of caustics, chlorides, fatty acids . . . from corrosive slurries or wet steam.

They resist wear, extend effective life of valves, seals, impellers and other parts exposed to heat and metal-to-metal abrasion in corrosive media.

They reduce fabricating costs too, because Ni-Resist irons provide needed properties in economical *cast* form. Pipes, kettles, vessels, filter components and many other simple or complex shapes are produced at moderate cost, are easily machined and welded.

Get the full story of Ni-Resist irons in the 70-page booklet, "Engineering Properties and Applications of Ni-Resist Irons." 105 applications are described, and some may surprise you! Write today.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

NI-RESIST

NICKEL MAKES CASTINGS PERFORM BETTER LONGER

For more data on advertised products, use Readers' Service Cards, last page.

How to Do It . . .

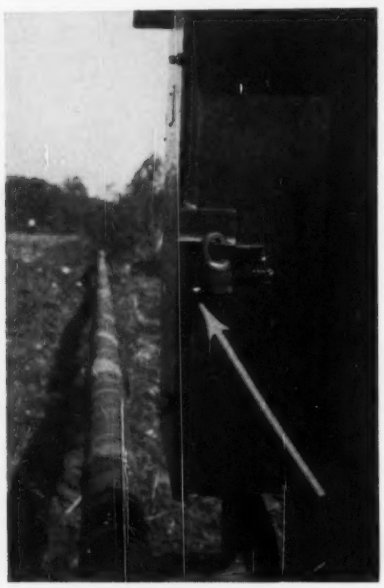
$T_2 = 70 + (30 - 35)\ (7.1) = 70 - 35.5$

$T_2 = 34.5°\ C$

Item submitted by William H. Morrison, United Engineers & Constructors, Inc., Philadelphia.

Grease Connection Makes Locks Waterproof

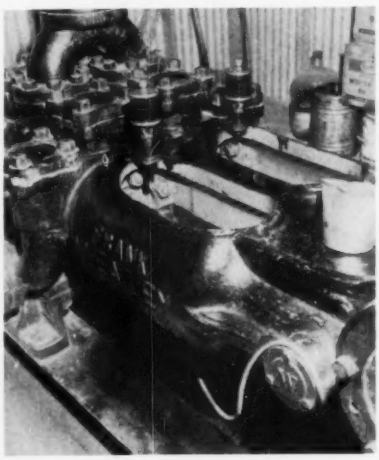
One plant maintenance superintendent who was continually troubled with corroding locks found a simple way to remedy the situation. Near the bottom of every lock in his plant, he drilled a hole and tapped it with threads for a grease fitting. When the locks were shipped from the supply store, he installed the fitting and filled the insides of the locks with grease which would not burn or melt at the highest temperatures to which the locks would be subjected.



All of the locks in the plant remain full of grease and there is no chance for rain and dew to penetrate them. If for any reason the locks become tight, a shot from the grease gun will free it up. The grease first finds its way to the keyhole, but upon further operation of the gun, the keyhole will not give up the grease fast enough and it is carried to all parts of the lock, finally emerging at the hasp connections bringing dirt and grime with it.

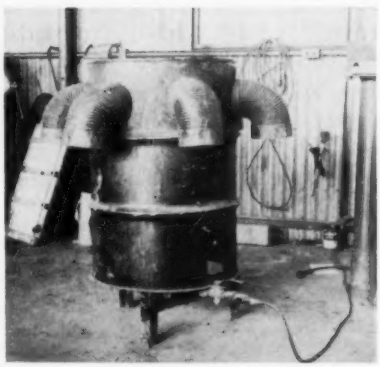
Oil Bath Lubricates Piston Rods in Corrosive Service

Where reciprocating pumps must work in a corrosive atmosphere or where corrosive liquids are pumped, the entire compartment housing and piston rods can be flooded with oil to keep the rods lubricated and away from the atmosphere.



The connection is made by taking the drain line from the chamber and running it back up over a bearing so that it holds the proper level in the chamber. If the packing glands leak product that is heavier than the oil, it will drain out the bottom and still keep the rods bathed in oil. If it is lighter, it will dilute the lubricant which will require it to be changed when the packing gland is repaired and tightened.

Homemade Stove Warms Shop Floor in Winter



A homemade stove can be rigged up using a 55-gallon drum to serve the shop during construction periods. Six ells of stove pipe material are welded to the top of the drum so that the heat is directed downward. This keeps the floor of the shop warm and makes it easy for the men to warm their hands and feet during breaks in the work period.

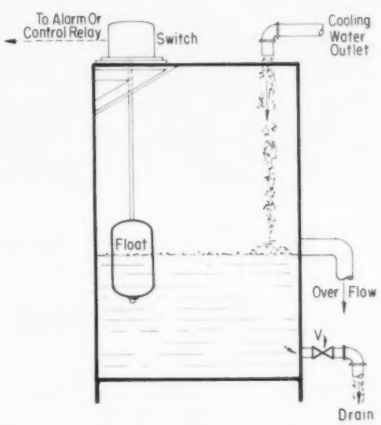
The drum is set on three legs made from angle iron welded together so that the burner, made from a 2-inch nipple of pipe with a 1/16-inch jet in the center rests on the bracing. A door on the front for lighting and inspection completes the stove.

Float Switch Alarm Checks Cooling Water Flow

It is really a good idea to use a float switch as a packing gland leakage detector (PETROLEUM REFINER, Vol. 39, No. 9, Page 332).

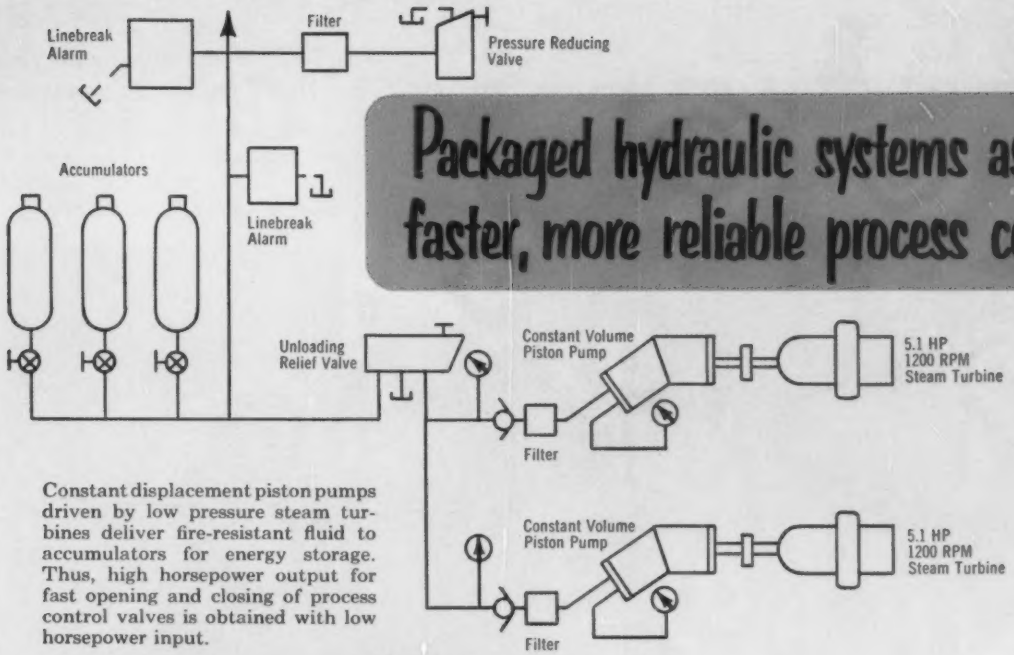
Besides this application, it can be used as a cooling water caretaker of compressors, refrigerators, hot oil pumps, engines, etc.

The drawing illustrates how a simple vessel and float arrangement can be made to check on cooling water flow to this equipment. The outlet of the cooling water system is piped into a small vessel and a float switch is installed on it. Adjust the drain valve, V, so that a small quantity of water is flowing through the overflow pipe. Whenever the cooling water from the equipment being protected falls below a predetermined amount, it will lower the water level in the vessel and the float switch will ring an alarm bell or stop the equipment before the loss of cooling water can damage it.



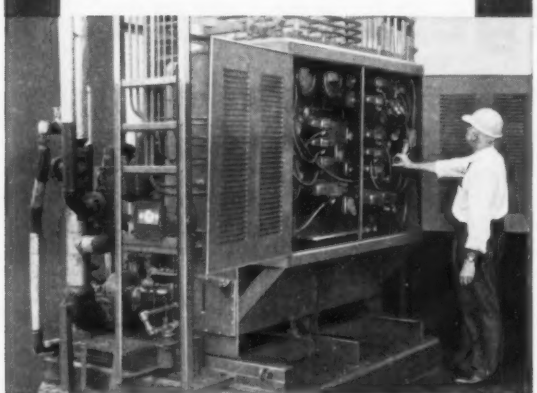
Item submitted by: Shou Chen Ting, Chinese Petroleum Corp., Taipei, Taiwan (Formosa).

Packaged hydraulic systems assure faster, more reliable process control



Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

Vickers complete packaged systems are ready to go into service upon arrival in your plant, since they are thoroughly pretested before shipment. They are properly designed and built to give maximum service life with little downtime, thus helping to keep your plant on stream.

Get more information on the job being done by Vickers packaged hydraulic systems in chemical, petrochemical, petroleum refining, and other processing industries by writing today for Bulletin I5802, "Packaged Hydraulic Systems for Process Control."

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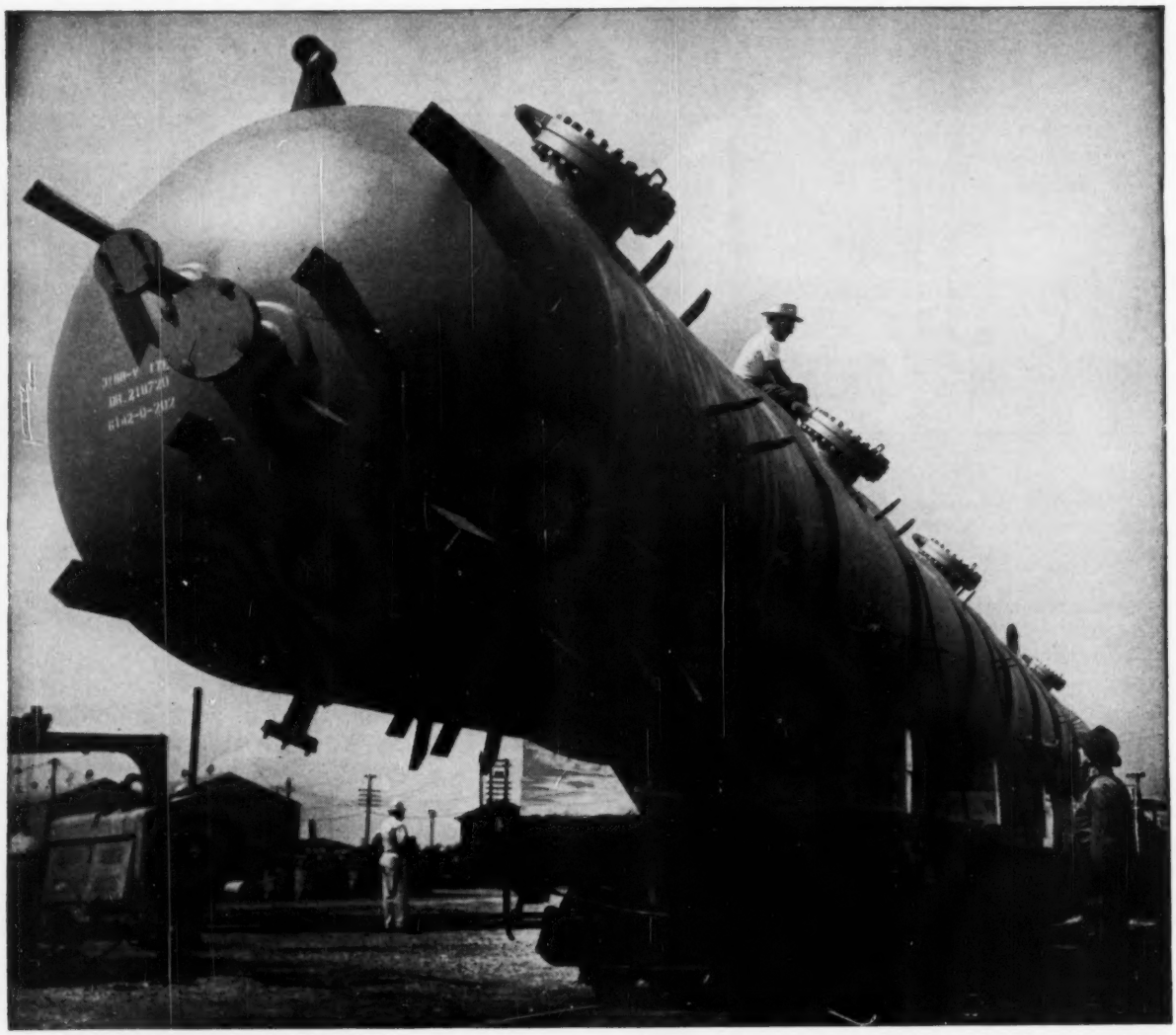


THIS ENTIRE VESSEL was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

Among the largest in use

...built by Newport News

This Debutanizer with a 110 feet 6 inches over-all length is typical of units that are readily built by Newport News . . .

In fact, Newport News can fabricate almost any type of pressure vessel or other heavy equipment used in the petroleum, chemical or other processing industries.

But at Newport News you'll find more than large productive capacity.

In vast fabricating shops, in huge machine shops, foundries and forging plants, Newport News craftsmen complete your order with specialized techniques. Plant methods . . . developed as a result of specializing for more than half a century . . . enable Newport News to provide money-saving answers to all sorts of heavy equipment problems.

Newport News craftsmen handle the job exactly as you want it done . . . for maximum results per dollar invested. So let us bid on your present or future projects. Learn how Newport News can help you. Send for our illustrated booklet entitled, "Facilities and Products"...it's yours for the asking.

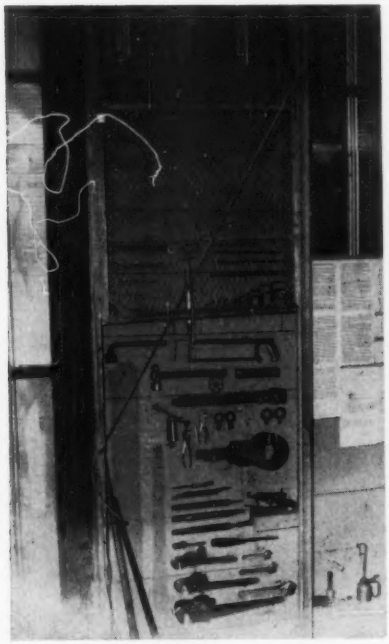
Engineers— Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

How to Do It . . .

Tools Available for Emergency, But Not Theft

The space between two-by-four's in the shop can be easily converted into a tool rack by placing a sliding door on the front and covering it with



chicken wire. Hooks are then put on the wall to hold the tools and a black outline painted around each tool.

At night, the door is pulled down and the mechanic slips a pad lock in the hasp. However, if the operator on duty needs a tool for an emergency, he can cut a hole in the wire and then report the use of the tool the next day.

Thus, the tools are easily seen are easy to get to by the mechanic and can be used in emergencies, but petty theft is discouraged.

Clean Tubes with Old Brushes and Steel Wool

An economical and efficient way to use old worn out tube cleaning brushes is to wrap the bristle section with industrial steel wool. The wool will pack down to the ID of the dirty tubes and do a really good cleaning and polishing job.

This new lease on brush life can be repeated almost ad infinitum.

Idea submitted by: L. Gorton, Canadian Chemical Co., Ltd., Edmonton, Alta., Canada.

True balanced vapor-pressure! That's why NICHOLSON STEAM TRAPS increase Thermal Efficiency . . . and Here's How!

When live steam contacts the bellows of a Nicholson Trap, the pressure inside the bellows equals the pressure outside. With both pressures balanced, the spring action of the bellows closes the trap. When condensate collects around the bellows, pressure inside drops causing outside pressure to compress the bellows and open the trap.

Briefly, this is true balanced pressure and is the operating principle of Nicholson Thermostatic Steam Traps. That's why they discharge condensate and air quickly, positively and intermittently . . . and why they help you get full thermal value from every pound of steam and full productive value from your steam equipment. They provide greater capacity, too . . . up to six times that of ordinary traps. And there's no steam waste either, because seats and valves are of hardened stainless steel, finely ground and accurately lapped for sure, tight shut-off.

As for maintenance, it's practically nil . . . and here's why. In this simply designed trap there is only one moving part. No links, pins, pivots or levers to go wrong. No adjustable orifices to stick, wear or become clogged. No need for valve and seat changing. In short, no downtime because of trap failure.

Naturally, plus efficiency like this does not come at "bargain" prices. You can get cheap traps, of course. But remember this: *price* only shows up on the dealer's shelf; *value* is what shows up on your lines . . . and with Nicholson Traps it shows up in discharge action you can rely on to keep temperatures high and even for full thermal efficiency at point of steam use . . . efficiency that can often increase production as much as 20%.

This is low trap cost, where it really counts. Let's tell you more.

W. H. NICHOLSON and COMPANY
12 Oregon St., Wilkes-Barre, Pa.
Offices in principal cities

Send for Catalog

W. H. NICHOLSON and COMPANY
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For more data on advertised products, use Readers' Service Cards, last page.

Who's Building in HPI...

Tall Tower, Concrete Make News

One of the largest concrete pours for a process plant ever made in the southwest and the erection of one of the tallest process towers ever lifted in one piece, has marked news at the site of the styrene plant being constructed for Sinclair-Koppers Chemical Co., Inc., in Houston (Pasadena), Texas. Badger Manufacturing Co., Cambridge, Mass., is handling engineering and construction of the 70-million-pound-per-year plant.

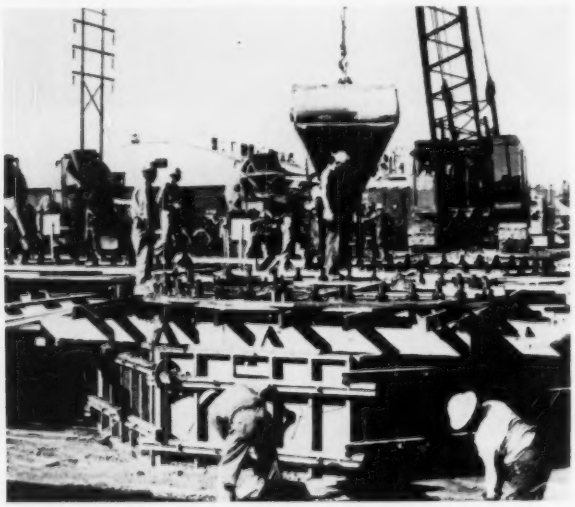
The concrete pour provided a monolithic 102 x 84-foot (variable thickness) slab and eight foundation bases for the main fractionating columns. Nearly 1,600 cubic yards of concrete were required. The entire operation was completed in less than eight hours.

The forms for the slab were laced with 200 tons of reinforcing steel, and the column bases included a total of 300 anchor bolts three inches in diameter and eight feet long. The concrete mix, especially formulated for the job, included an admixture to provide plasticity and workability. The mix was designed for compressive strength of 3,000 psi.

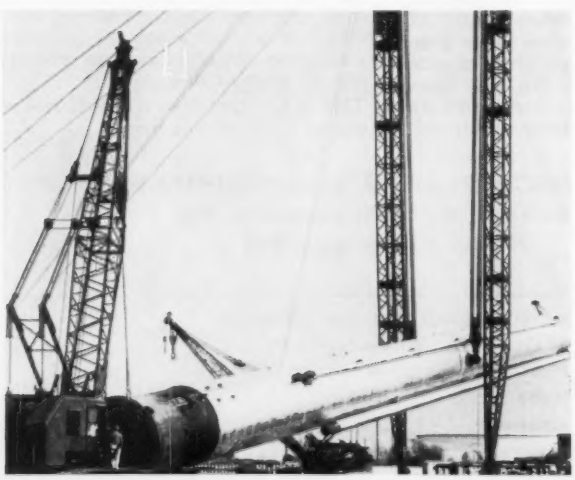
After a three-and-one-half-week cure period, the first of the mammoth fractionating columns, over 227 feet in length and weighing 300 tons, including trays and insulation, was lifted into place on the foundation.

The vessel set the record as the longest rail cargo ever hauled. Six flat cars were required for the movement.

Five similar towers and two other towers 158 feet in length will be installed adjacent to the column at a later date. All construction operations are on schedule and the plant is expected to be ready for operation in mid-1961 as originally planned.

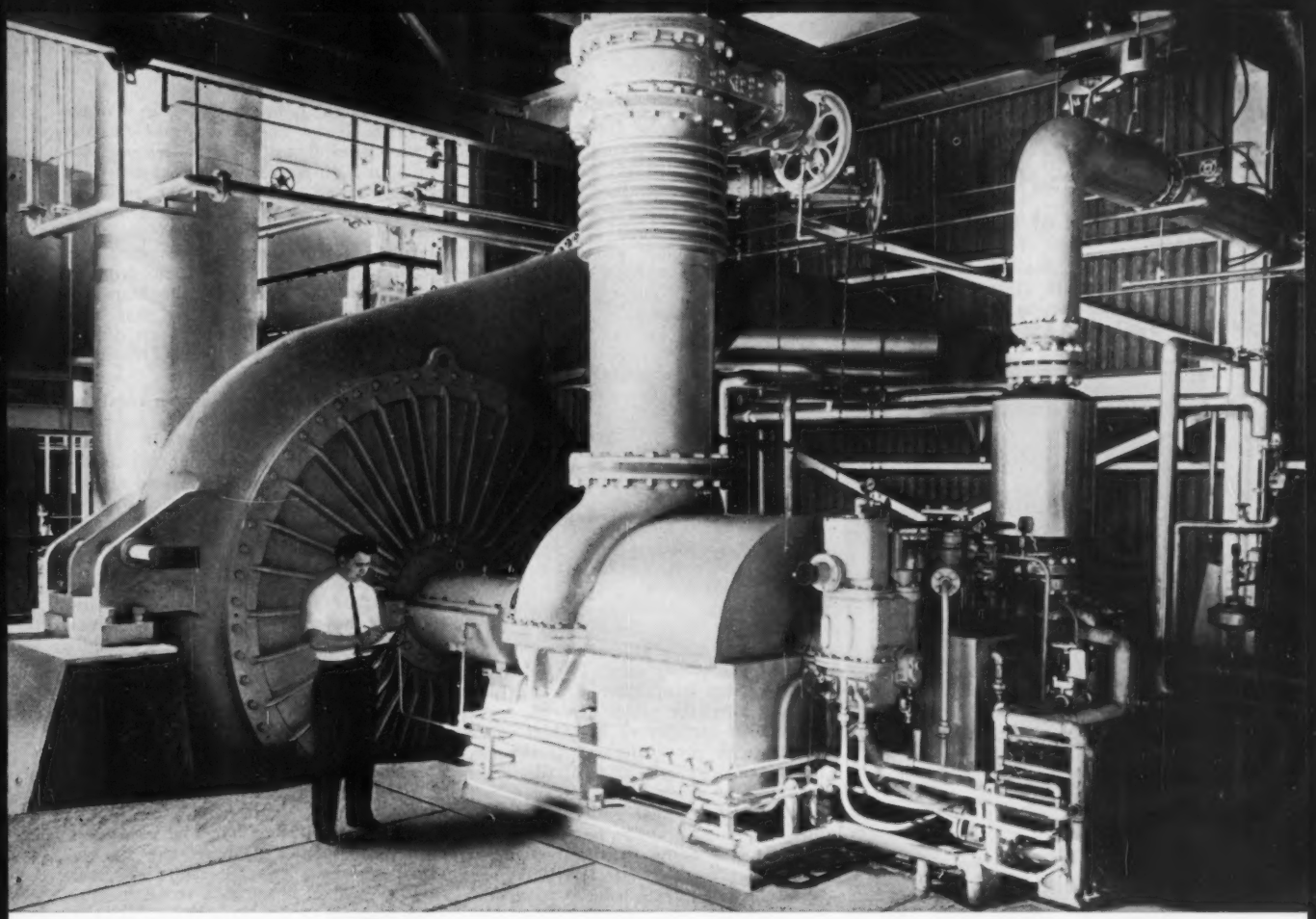


1. Concrete pour took less than eight hours.



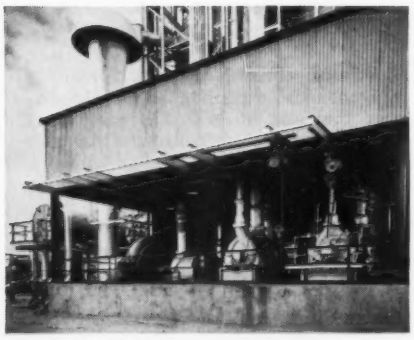
2. Vessel is being lifted in one piece.

3. Five other columns will take their places beside this one.



BIG SINGLE-STAGE ELLIOTT COMPRESSOR

furnishes combustion and lift air for TCC unit



In the compressor area are two Elliott multistage turbine-driven compressors, in addition to the large single-stage unit shown above.

The huge single-stage Elliott compressor shown above has inlet capacity of 74,750 icfm. It serves as a combination combustion air and lift-air compressor for a Thermofor catalytic cracking unit in a southern petroleum refinery. Inlet temperature is 100°F; inlet pressure, 14.3 pisa; discharge pressure, 19.5 pisa. The compressor is driven by a 2200-hp, 3000-rpm Elliott turbine.

Elliott makes a complete line of centrifugal compressor units, consisting of single-stage, multistage and axial flow machines, with integrated Elliott motor or turbine drives. There are 48 frame sizes, permitting accurate matching of compressor to application requirements over the entire range of capacities, from 500 cfm to 600,000 cfm.

For full information, consult the nearest Elliott office, or write Compressor Department, Elliott Company, Jeannette, Penna.

ELLIOTT THE MOST COMPLETE LINE OF **INTEGRATED COMPRESSOR & DRIVER UNITS** 500 cfm to 600,000 cfm

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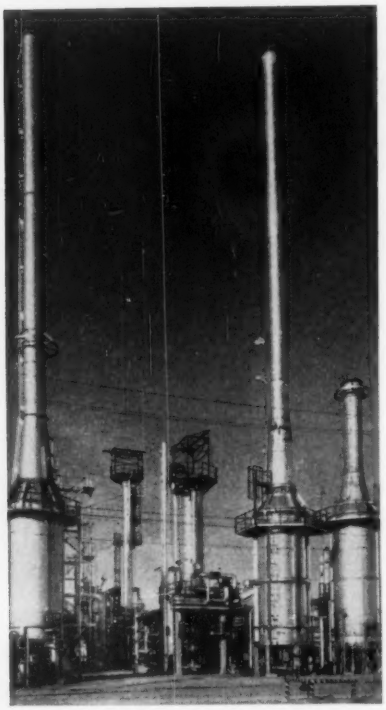
PO-3

Building . . .

Texaco Puts Hydrotreater On Stream at Casper Plant

Texaco, Inc., has put a new hydrotreater on stream at its Casper, Wyo., refinery. Construction, detail engineering and purchasing were done by Badger



Manufacturing Co., Cambridge, Mass. Process engineering was carried out by Texaco's Engineering Department.

Humble Oil & Refining Co. is planning to expand its Baytown refinery facilities to double the refinery's benzene and toluene production capacity. Benzene production at Baytown will be increased from 30 million gallons to 55 million gallons per year, and annual toluene capacity will be increased from 32 million to 55 million gallons. Humble also has an annual production of 25 million gallons of benzene at its Baton Rouge, La., refinery. The benzene-toluene expansion project will involve addition of equipment at Humble's present Baytown benzene unit site so as to make the unit into a larger, more versatile plant. Another part of the program will be the construction of toluene dealkylation facilities at the plant, using a process developed in Humble's Research and Development Division. A third phase of the program will add toluene extraction facilities.

Shell Oil Co. has awarded a contract for construction of a gasoline plant in the North Rincon field, Starr County, Texas. Successful bidder was the Fish Engineering Corp. of Houston. The plant will be a joint venture of Shell and Arkansas Fuel Oil Corp. Construction has already begun, with July 1 as the tentative date for completion. While some existing facilities will be utilized, the North Rincon plant will be a complete and separate installation. It will serve primarily the North Rincon and La Copita fields, both in Starr County. The plant will have a design capacity of 35 MMcf of gas daily from which it is estimated that approximately 80 percent of the propane and essentially all of the heavier liquid hydrocarbons contained will be recovered. Recovery output of the plant is expected to include approximately 15,500 gallons of propane, 14,000 gallons of liquid petroleum gases and 7,900 gallons of gasoline daily.

Pan American Petroleum Corp. has announced start-up of its Empire-Abo gasoline plant, located some 13 miles southeast of Artesia, N. M. The plant is owned 50 percent by Pan Am and 50 percent by Hondo Oil and Gas Co. Pan Am is operator. Located on a 20-acre site, the plant has an initial compressor capacity of 10 MMcf of gas a day, with processing vessels designed for a capacity of 20 MMcfd. When operating at design rates, the plant will recover some 42,000 gallons a day of liquid product, propane, butane and natural gasoline. Sulfur will be recovered in a special unit design by Pan American. Residue gas is being sold to a pipeline company for eventual use as a fuel. (PETROLEUM REFINER, Vol. 39, No. 2, Page 178.)

Kerr-McGee Oil Industries, Inc., has started construction on the first privately financed helium extraction plant to be built in the United States. The plant, to be built in the Pinta field, Apache County, Arizona, will process 2.5 MMcfd of gas. Air Products, Inc., Allentown, Pa., is designing and engineering the facility. The heart of the helium recovery plant is the low-temperature crude extraction equipment. At the Pinta dome this equipment will remove helium rich product from the crude gas stream. Extraction is accomplished by cooling the feed gas with liquid nitrogen to below —300° F, at which temperature most other components in the stream are liquefied and separated from the helium. Rich helium product from this process is then delivered to the final purification section of the plant where the remaining impurities are removed by adsorption.

Petro-Tex Chemical Corp. plans to construct a new chemical plant at its Houston location. The plant will produce tetrahydrophthalic anhydride for use in plastics and paint. The new chemical will be a logical addition to Petro-Tex's growing list of chemicals derived from light hydrocarbon gases.

Suntide Refining Co. will start construction of an ethyl benzene separation unit March 1 at its plant in Corpus Christi, Texas. The plant, Suntide's sixth petrochemical unit, will be designed for a 30-million-pound-per-year capacity. It is scheduled for completion early in July. The new unit will be a further separation step of the mixed xylene product of the Udex unit and will operate in conjunction with the Udex and orthoxylene separation units. Badger Manufacturing Co., Cambridge, Mass., has been awarded the contract for process design, engineering and construction of the unit.

Murphy Corp. is planning a construction program at its refinery in Superior, Wis. Additions to the plant will include a fluid catalytic cracking unit of 5,000-bpd capacity, a hydrofluoric acid alkylation unit of 1,200-bpd capacity to produce high octane gasoline for blending into motor fuels, a 400-bpd increase in distillate fuel desulfurizing capacity, and an increase in gasoline treating capacity from 1,500 bpd to 4,500 bpd. In addition to the new process units, construction will include 200,000 barrels of additional tankage, a tetraethyl lead blending plant to replace an existing unit, and a new laboratory building.

Continental Oil Co. has awarded Manhattan Construction Co., Muskogee, Okla., a contract for the $2,200,000 expansion of its research and development facilities in Ponca City. The expansion program includes doubling the size of Conoco's main research laboratory and construction of a separate research services building.

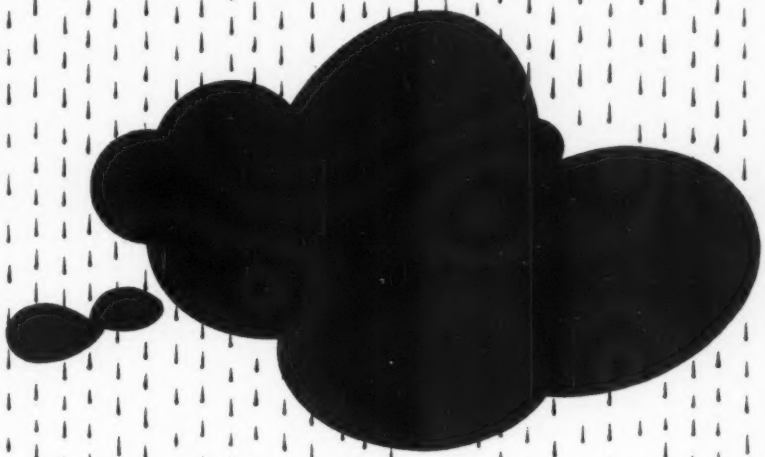
Houston Corp., St. Petersburg, Fla., will build a gas extraction plant at Brooker, Fla., to cost $7 million. Houston has organized a new company, Florida Hydrocarbons Co., to construct and operate the plant.

Armour & Co. will triple its capacity to produce nitrogen and concentrated phosphate at its two plants in Southern United States. The plants represent a large portion of the company's $60-million program for expanding agricultural chemicals facilities.

Reichold Chemicals, Inc., plans a petrochemical expansion in the Houston area this year to cost $10 million. A vinyl acetate monomer plant will be built to produce 50 million pounds annually, with planned expansion to 100 million pounds.

Rexall Drug & Chemical Co. will build a polystyrene plant near Chicago. The facility, which will have an annual capacity of 25 million pounds, will raise Rexall's polystyrene capacity to 70 million pounds per year. El Paso Natural Gas Co. will furnish the styrene feed stocks for the plant.

Sun Oil Co. will construct a $9,300,000 gas plant at its Marcus Hook, Pa., refinery to separate 14.4 MMcfd of dry gas, 7,100 bpd of liquefied propane and pro-



CONSTRUCTION ON TIME, "WEATHER" OR NOT ....

...when Lummus designs, engineers and constructs your new process industry plant. Six Lummus organizations circle the globe. Over 50 years of world-wide experience on over 850 installations for the process industries.

Lummus completed the 25,000 barrel per day refinery for BP Refinery Canada Limited near Montreal **on time** in 1960—despite record-breaking cold weather conditions and an accelerated completion schedule. 120 inches of snow fell over the 1959-60 winter. (Even in an average year, Canadian temperatures may vary 110° and humidity 80%—which produces drastic contractions and expansions in piping, steelwork, roads.)

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MATHESON GAS MIXTURES for Instrument Calibration

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Oxygen Analyzers
Gas Chromatography
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Practically any mixture of the 85 gases listed in the Matheson Compressed Gas Catalog can be supplied, to your specifications. This Catalog contains information on the world's most complete line of compressed gases, and gas regulating and handling equipment.

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THE MATHESON COMPANY, INC.
East Rutherford, N. J.;
Joliet, Ill.; Newark, Calif.

Building . . .

pylene, 13,200 bpd of liquefied butane and 18,000 bpd of gasoline. Completion is scheduled for November 1961.

Great Lakes Oil & Chemical Co. and Houston Chemical Corp. have joined in the bromine manufacturing business. The new concern, Arkansas Chemicals, Inc., will be owned 50 percent by each company. The firm will begin construction on a $1.5-million plant near El Dorado, Ark., to be completed next July.

Ashland Oil & Refining Co. proposes to build a Udex unit to manufacture benzene, toluene and xylene at its Catlettsburg, Ky., refinery. When the unit is constructed, the benzene capacity for the refinery will be approximately 15 million gallons per year. A new vacuum unit, under construction at Catlettsburg, will replace three smaller vacuum units, and will increase the refinery's capacity to produce asphalt.

Tennessee Eastman Co. has entered the second phase in the multimillion-dollar construction program of production facilities for its new polyester fiber. The firm has planned two plants, one for the manufacture of terephthalic acid and the other for dimethyl terephthalate. Work is now under way on the installation of underground utility service lines. The projects are scheduled to be completed during the latter part of 1961.

Monsanto Chemical Co. will construct a major plant on a 3,000-acre site at Chocolate Bayou, Texas. The production facility, in Brazoria County near Alvin, Texas, will include the world's largest ethylene plant, with an annual capacity of more than 500 million pounds, and will produce significant quantities of other important hydrocarbons. The major part of the plant's output will be used as raw materials by other operating units of Monsanto. The plant, scheduled for operation in 1962, will also produce propylene, cumene, phenol, acetone, ethyl benzene, and other hydrocarbons. Monsanto has assigned a group of its top engineers to the project. Bechtel Corp. of San Francisco will assist in the design and construction.

Hercules Powder Co. is doubling its linear polyethylene capacity at Parlin, N. J. The extra capacity will be drawn from present polypropylene capacity at Parlin, which will be replaced by Hercules' polypropylene unit at Lake Charles, La.

Champlin Oil & Refining Co. has awarded Fluor Corp., Ltd., a contract worth about $1.5 million to complete the design, detailed engineering, purchasing and construction of a 4,000-bpd delayed coker at Champlin's refinery at Enid, Okla. The project involves converting an existing thermal catalytic cracking unit into a delayed coker.

Heyden Newport Chemical Corp. has started construction of a fumaric acid plant at Garfield, N. J., expected to go on stream in the second quarter of 1961. Heyden Newport has obtained from Scientific Design Co., Inc., the rights to a process to produce fumaric acid. Heyden Newport has placed two new plants on stream since November 1960 and four more are due for completion within the next three months. One of these, a 24-million-pounds-per-year maleic anhydride plant, is scheduled to go on stream in the first quarter of 1961.

Tennessee Gas Transmission Co. plans to build a plant on the Houston Ship Channel to make acetylene and vinyl chloride monomers. Cary Chemicals, East Brunswick, N. J., will team up with TGT in the venture. Initial capacity of the plant will be 100 million pounds per year. Construction will probably begin in the third quarter of this year.

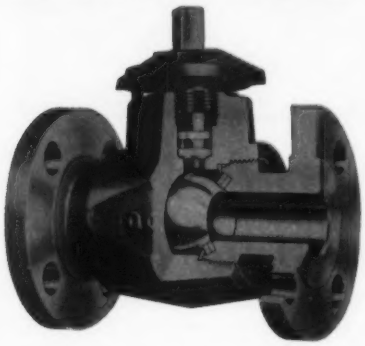
British American Oil Co., Ltd., is installing a $1 million carbon monoxide boiler and extraction steam turbine, which will supply power for a major portion of the company's Clarkson refinery, 20 miles west of Toronto. The CO boiler is designed to aid in heat recovery and disposal of waste gas by burning carbon monoxide and unburned hydrocarbons produced in the refinery's catalytic cracking operation. It will provide steam power for the recently completed alkylation unit, complement the high pressure steam boiler at present supplying the catalytic cracking unit and also provide for future power needs resulting from plant growth. Combustion Engineering, Inc., and Canadian Westinghouse Co. Ltd., are contractors for the project which is already under way and scheduled for completion next fall.

Mobil Chemical Co. and Chinese Petroleum Corp. have submitted a joint application to the Republic of China government to build a 100,000-metric-tons-per-year urea plant in Taiwan.

Russia has lost the right to build Ethiopia's first refinery at Assab on the Red Sea. Reports say that Emperor Haile Selassie has withdrawn an agreement for the building and supplying of a 1.8-million-ton-per-year plant because it would make Ethiopia entirely dependent on Russian crude.

Esso Standard Italiana has been granted permission from the Italian government to construct a refinery in the province of Pavia, Italy. The plant will have an atmospheric distillation unit with a capacity of 3.9 million tons per year, and a catalytic reformer of 610,000 tons per year. Two refineries are proposed by

LEAKPROOF AFTER 600,000 CYCLES!



Proved in the laboratory, and in over five years of field service with such difficult ladings as acetone, propane, vinyl chloride, and lime and soda-ash slurry, W-K-M's ACF Ball Valve has earned a reputation for extra long life *without lubrication*. For example —

In one test, W-K-M opened and closed a 2″ standard production model under pressure 600,000 times. The valve still sealed tight, and there was no measurable wear on either the chrome-plated ball or the Teflon seats!

W-K-M's rugged ACF Ball Valves are available in carbon steel to ASA 300 lbs. (some sizes 600 lbs.), and in semi-steel, ASA 200 and 400 lbs. WOG.

Write for Catalog 1000.

Conduit is full-bore; Teflon stem gaskets and seats are sealed from the lading flow.

WHEN SO MUCH DEPENDS ON A VALVE . . . SPECIFY ACF BALL VALVES

W-K-M

DIVISION OF ACF INDUSTRIES INCORPORATED
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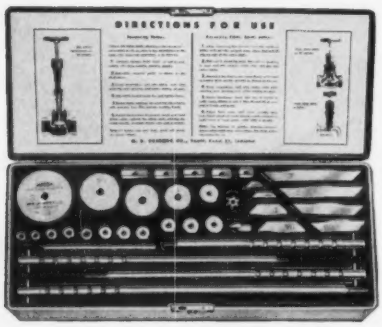
RESEATS VALVES and BIBBS QUICKLY ECONOMICALLY



Easily pays for itself on the first two jobs!

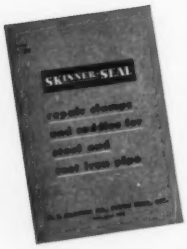
Reseats flat and tapered-seat globe or angle valves—all bibbs and faucets—in place, quickly and accurately. The saving, over tearing out and renewing leaky valves and fixtures, is tremendous.

Cutters operating under screw feed, leave worn, scored seats glass-smooth, level, absolutely accurate and tight.

A guide pilot centers each cutter; a tapered cone centers each spindle. Perfect alignment is inevitable. Cutters guaranteed. Write for literature!

2" for ¼" to 2" valves and ¼" to ¾" bibbs
List price $59.85

3" for ¼" to 3" valves and ¼" to ¾" bibbs
List price $79.50



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catalog showing our pipe repair clamps, saddles, and reseating tools

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

Building . . .

the company in Sardinia, both with 1.2-million-tons-per-year capacity. The firm has also gained permission to expand the Garrone refinery in Genoa, the API refinery in Falconara, and Aquila in Trieste, all to 2.3 million tons per year. The Sarom plant in Ravenna is to be enlarged to 4 million tons per year.

Esso Standard SAF plans to construct a hydrogenation unit and aromatics plant at its Port Jerome refinery near Le Havre, France. The hydrogenation unit will go on stream in the second half of 1961 with a 700-metric-tons-per-day capacity. The aromatics plant, with a capacity of 45,000 metric tons per year, will go on stream in the first half of 1962.

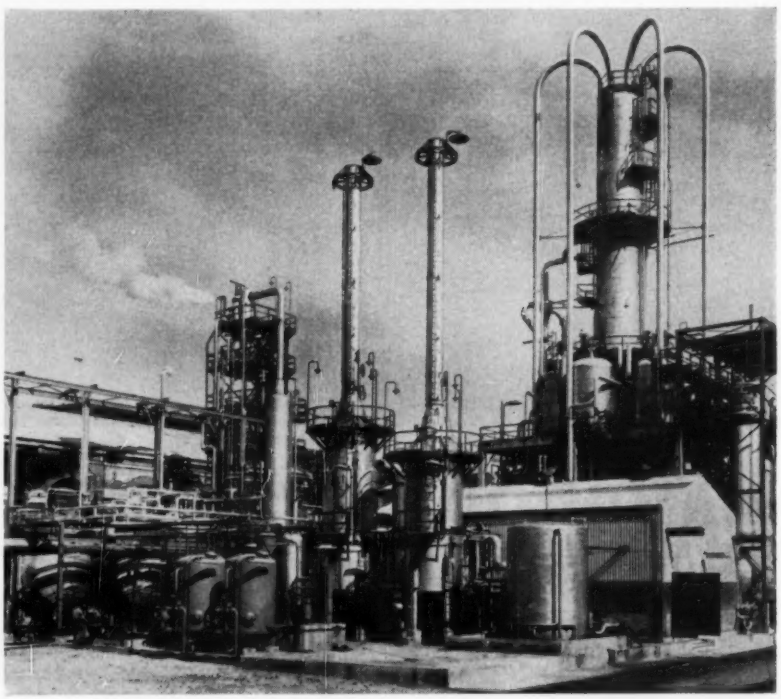
Iraanse Aardolie Raffinage Maatschappij N.V. (Iranian Oil Refining Co.) has awarded a contract worth approximately $5 million to Fluor-Schuytvlot N.V., Haarlem, Holland (a subsidiary of The Fluor Corp., Ltd.) for the design, detailed engineering, purchasing and construction of a 20,000-bpd U.O.P. Unifiner-Platformer to be added to its refinery at Abadan, Iran.

African Explosives and Chemical Industries (Rhodesia), Ltd., plans to build a nitrogen plant at Salisbury, Southern Rhodesia, within 18 months. Cost of the facility, which is expected to be in operation about 1965, will be $27 million.

Nippon Oil Co. has asked for Japanese government approval to build a refinery at Nishinomiya, Japan, between Osaka and Kobe. The plant will process 150,000 to 200,000 bpd of oil.

Shell Oil Co. and British Petroleum Co. are working on a proposal for a joint $16.8-million refinery in the Sudan. The two companies were invited to submit a counterproposal to a refining bid from ENI by the Sudanese government.

Australia has invited four construction firms to submit contract bids for South Australia's first refinery. The plant will be erected at Hallett's Cove, south of

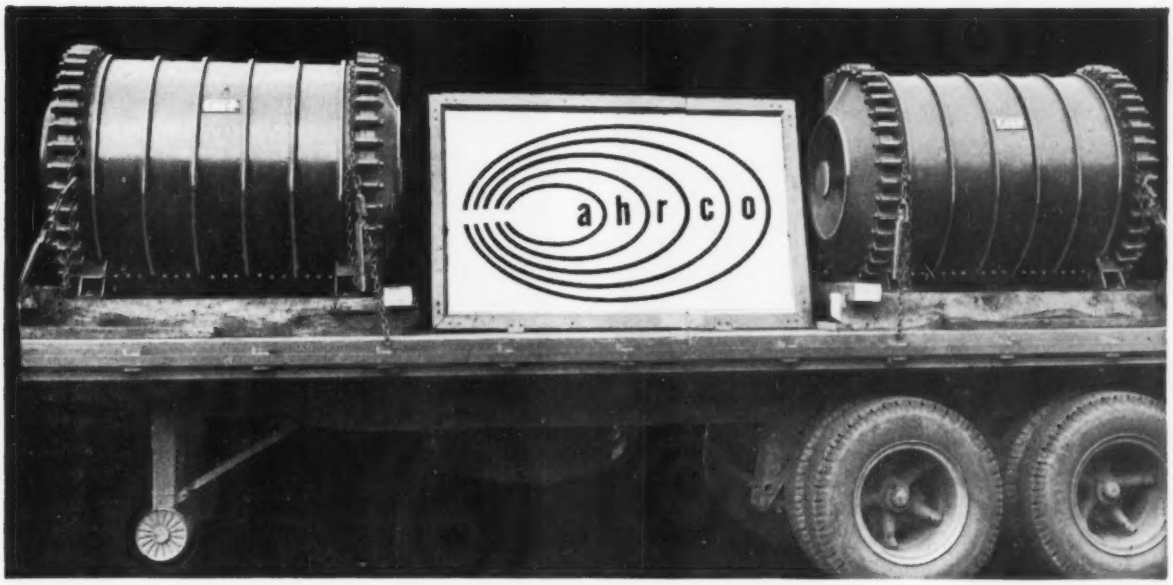


Badger Completes ACNA Phthalic Plant in Italy

Asiende Colori Nazionali Affini, a subsidiary of the Montecatini group, has completed the design, engineering and construction of a 22-million-pound-per-year phthalic anhydride plant at Cengio, Italy. Badger Manufacturing Co. was the supervising contractor.

The new plant is the largest phthalic anhydride plant in Italy, and the first to employ a fluid bed catalytic process. The process is licensed exclusively by Badger under an arrangement with Sherwin-Williams Co.

For more data on advertised products, use Readers' Service Cards, last page.

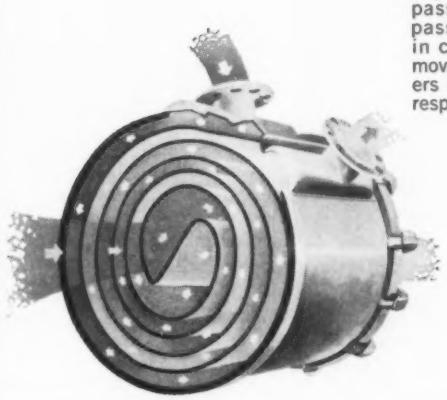


Here go 2520 square feet of heat transfer surface!

Two of a battery of 18 identical AHRCO Spiral Heat Exchangers are shown heading for a coke oven plant, for use as wash oil coolers. Compactness, high performance, long pass, full counter-flow, low fouling characteristic, and ability to handle slurries and fluids with solids in suspension: these are the features that warrant your investigation of this unique heat exchanger. It has a proven performance record. See it at Booth 315, at the New Orleans A.I.Ch.E. Show.

SPECIFICATIONS FOR EACH UNIT

SURFACE:	1260 sq. ft.
WEIGHT:	17,140 lbs.
DIAMETER:	48 inches
OVERALL LENGTH:	78 inches
PASS LENGTH:	126 ft. each side
DESIGN PRESSURE:	150 p.s.i.
MATERIAL:	1/4 inch carbon steel plate, SA-285
DESIGN:	The Spiral Exchanger is an assembly of two long plates wrapped up to form a pair of adjacent passages, with each passage rectangular in cross-section. Removal of the end covers fully exposes the respective passages.



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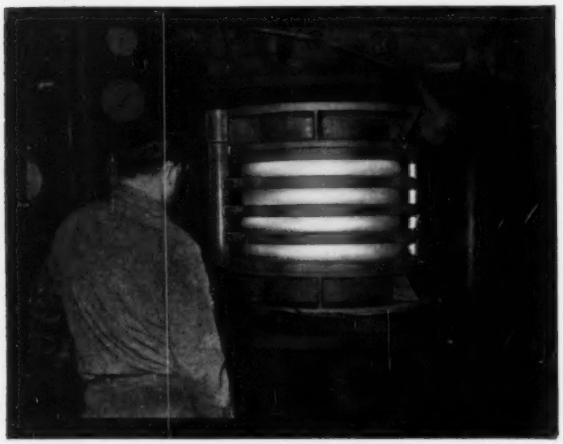
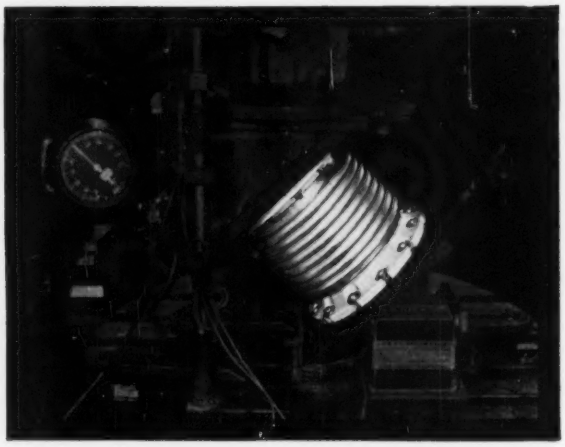
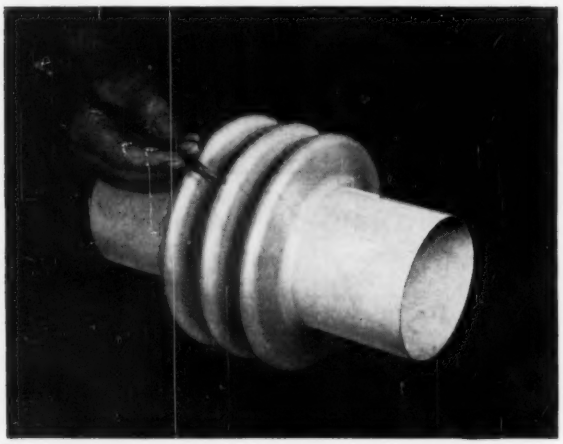
4 WAYS to get maximum reliability in expansion joints



1 Insist that the corrugated bellows be hydraulically formed. The reason is simple. Whenever bellows are formed by circumferential welding . . . whether by edge, seam or fillet welding . . . they will always be subject to premature failure because of stress concentrations at the welds.



2 Be sure the manufacturer maintains a continuous and comprehensive program of endurance testing. This is basic, because of the many variables that affect expansion joint life. Accurate determination of expansion joint life expectancy can only be determined by cycling to destruction.



3 Demand proof that the manufacturer can produce longitudinal welds in the corrugated bellows having the same strength, physical properties and thickness as the parent metal . . . without grinding. A weld that is hard to find is a ground weld. Variations in weld thickness set up points of stress concentration . . . opening the way for premature failure.

4 Check the ability of the manufacturer to supply a team of *competent* design and application specialists to work with your engineers. Check their specific experience in handling critical, complex applications in your field . . . complete to the record of successes or failures behind them, and details of how this experience will be brought to bear on your problem.

At Zallea, none of the many factors affecting expansion joint reliability are left to guesswork . . . including the four vital ones above.

This is reflected in these facts. Zallea material specifications are the most exacting in the industry. Zallea expansion joints are hydraulically formed. Zallea advanced welding techniques insure welds having the same thickness, strength and physical properties as the parent metal. Zallea has done more cyclic testing to destruction than all government agencies and industrial firms combined. Zallea has produced more expansion joints than any other manufacturer . . . offers more application engineering experience.

For all the facts, write for Catalog 56. Zallea Brothers, Taylor and Locust Streets, Wilmington 99, Delaware.

Zallea for maximum reliability

ZALLEA BROTHERS, Wilmington 99, Delaware • World's largest manufacturer of expansion joints

Building . . .

Adelaide. The companies to submit bids are Bechtel Corp., Foster Wheeler Co., The M. W. Kellogg Co., and Fluor Corp., Ltd.

Imperial Chemical Industries, Ltd., has placed Britain's first plant for the bulk manufacture of polypropylene on stream at the Wilton Works in Yorkshire. The new unit has a capacity of 11,000 tons per year. The main plant has been built at high speed. Work on the site began in May 1959 and the completion date was set in September 1960. The project was divided into self-contained units. The company's engineers undertook the design of some of these units and the rest were designed by Constructors John Brown, Ltd.

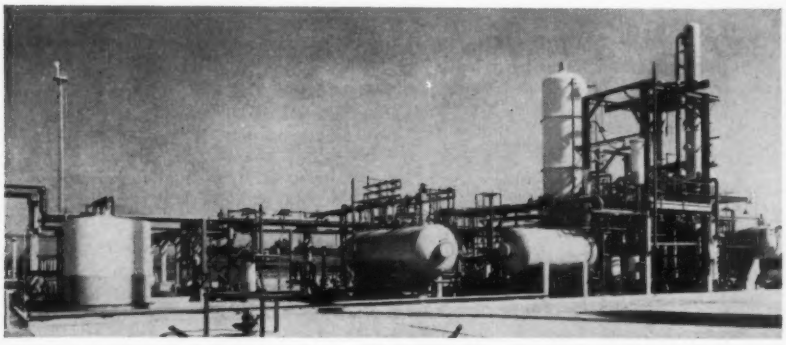
Yugoslavia will produce polyethylene, styrene, polystyrene, phenol, and acetone with the completion of a petrochemical complex at Zagreb. The U.S. Development Loan Fund, and other financial interests in England and Yugoslavia provided the investment funds for the project. Eight processing units and complete offsite facilities will comprise the plant. Foster Wheeler Corp., New York, will furnish detailed mechanical engineering and will supervise construction.

Argentina has accepted Fish International's offer to invest some $70 million in a petrochemical complex at San Lorenzo, near Rasario, Argentina. Bids submitted by Texas Butadiene & Chemical International to build similar facilities at Puerto de Seado, Santa Cruz province, have been withdrawn.

British Petroleum Co., through its French associate, Societe Francaise des Petroles BP, is to have an interest in two new refineries to be built in France and Algeria, both to come on stream early in 1963. Societe de la Raffinerie de Strasbourg S.A. has been formed to build a refinery at Herrlisheim, about 15 miles north of Strasbourg, France. The refinery's capacity will be about 66,000 bpd. Total cost of the venture is estimated at approximately $61,600,000. Societe de la Raffinerie d'Alger has been formed to construct a 50,000-bpd refinery at Maison Carree, near Algiers. The refinery will include an atmospheric distillation unit and a catalytic reformer to process Hassi Messaoud crude and Hassi R'Mel condensate in order to meet the main product requirements of the expanding Algerian market. The estimated cost of the refinery is approximately $47,600,000.

British Celanese, Ltd., subsidiary of Courtaulds, Ltd., London, is building an aromatics condensate separation unit at its chemical plant in Spondon, Derbyshire, England. The unit, which is due to go on stream in August, will produce nitration grades of benzene and toluene, as well as xylene. A cyclopentadiene recovery unit will also be included.

Societe Francaise des Petroles and British Petroleum Co. have installed plant and storage facilities at the Lavera, France, refinery to produce up to 100,000 tons per year of bitumen. The project is expected to be commissioned in the first half of 1962.



Ethyl Corp. of Canada Completes Sarnia Plant

Ethyl Corp. of Canada, Ltd., has completed construction of an ethyl chloride-ethylene dichloride plant at Sarnia, Ont. Canadian Badger Co., Ltd., was the contractor. Construction began on the plant in September 1959 and, according to plan, operations were suspended during the winter months and resumed in April. The units have been readied for operation and will go on stream as the necessary raw materials become available.

Ethyl chloride is manufactured from ethylene and anhydrous hydrogen chloride in the presence of a catalyst, and ethylene dichloride is manufactured from ethylene and chlorine. Ethyl of Canada will purchase its supplies of ethylene, hydrogen chloride and chlorine locally.

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DEMANDS A MODERN THERMOMETER

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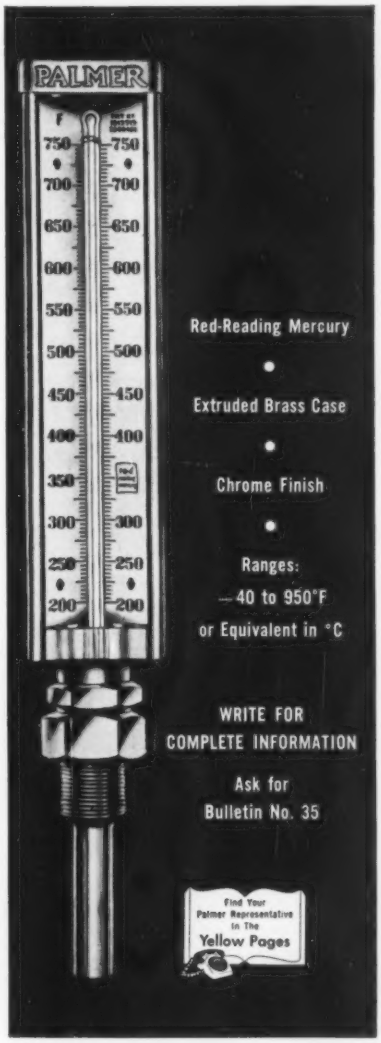
RED-READING MERCURY THERMOMETERS



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BOROHYDRIDES
improve product purity at marginal cost

Without altering your existing process, it is now easy and inexpensive to remove residual aldehydes, ketones or peroxides from your product with sodium borohydride. At marginal cost, it cleans up minor amounts (0.5% or less) of these unwanted contaminants by simple contact methods. In most cases, the borohydride technique offers broad advantages over complex catalytic hydrogenation, distillation, and other types of chemical treatment. Here's why:

Three Product Forms: For fixed-bed purification, sodium borohydride is available in 10/32" and 24/32" pellet form. For simple addition to your product stream, it is also available as a pure powder and in a form called SWS, a stable, aqueous caustic solution.

New Low Prices: As quantity production of sodium borohydride rolls into high gear, prices have dropped significantly. Current prices for annual contract quantities, in fact, are lowest in the product's history.

New Hydride Technology! Interest in sodium borohydride is unprecedented. As a result, a mountain of technical information is now available. MHI will gladly share this technology with you.

Write for comprehensive technical bulletins! Without obligation, MHI will up-date your library on sodium borohydride. Helpful technical service, too, is yours for the asking.

PIONEERS IN HYDRIDE CHEMISTRY

MHI *Metal Hydrides Incorporated*

601 CONGRESS STREET
BEVERLY, MASSACHUSETTS

Building . . .

British Petroleum Co., Ltd., plans to build a plant at its Kent refinery to increase production of premium grade petroleum. The unit, a catalytic reformer, will convert low-octane naphtha and benzine into high-octane components. The facility will have a capacity of 23,000 bpd. Site preparation has already started and engineering work is under way. Completion is expected in early 1962.

Ethyl-Synthese has contracted Societe Belge De L'Azote et Des Produits Chimiques du Marly (SBA), Liege, Belgium, the planning of a plant to produce 25 to 30,000 tons of styrene per year. The unit will be installed at Lillebonne, in France, and will apply the technique granted by Koppers Co., Inc.

ANIC has a Houdry dehydrogenation process unit on stream at its Ravenna, Italy, site. The facility has a nominal design capacity of 20,000 short tons of butadiene annually. ANIC also has a plant for synthetic rubber at Ravenna.

Standard-Vacuum Refining Co. of Malaya, Ltd., recently formed by Standard-Vacuum Oil Co., proposes to build a refinery in Malaya. The plant will produce sufficient quantities of petroleum products to meet Stanvac's local marketing requirements.

Tunisia will have a refinery built near the port of La Skhirra by a joint Italian-Tunisian company named Stir. The plant will cost $14 million and have a capacity of 20,000 bpd. The unit is set to go on stream in 1962.

Swift & Borden Chemical Co., Ltd., is building a formaldehyde plant with an initial capacity of 13 million pounds per year at Sydney, Australia. The plant, which is scheduled to be completed next spring, is costing $250,000.

Esso Standard SAF is negotiating for a site on the Gulf of Foss, west of Marseilles, France, as the location of a new refinery. Completion of the plant will depend on the growth of consumption in France.

Cie. Rhenane de Raffinage and Raffinerie de Strasbourg have begun construction of two new refineries a few miles north of Strasbourg, France. Cie. Rhenane de Raffinage is owned by Shell, Caltex and Mobil.

Dutch State Mines will build The Netherlands' first formaldehyde plant at Beek in Limburg. The unit will have a capacity of 25,000 metric tons per year of 40 percent formaldehyde solution. The company has been increasing its production of caprolactum, urea, and high and low density polyethylene. A phenol plant, jointly owned by Dow Chemical Co. and Dutch State Mines, is nearing completion.

Societe Chimique de Selzaete, Brussels, Belgium, is building a maleic anhydride plant at Selzaete, Belgium. The plant, using a Scientific Design Co. process, will go on stream in early 1962.

Empresa Colombiana de Petroleos (Ecopetrol), the state oil concern of Colombia, is studying plans for construction of a refinery or expansion of the existing plant at Barrancabermeja. The company also plans to increase its crude production from the present 27,000 bpd to 75,000 bpd.

The Netherlands States Mines will construct a 10,000-tons-per-year facility to produce low-pressure polyethylene in The Netherlands.

Japan has five companies planning to build a refinery on Northern Kyushu. The group headed by Yawata Iron & Steel Co., Ltd., will probably operate the plant on North Sumatra crude initially.

Imperial Chemical Industries, Ltd., will construct a polyester plant to go on stream in 1963 at Kilroot, Ireland. Other fibers may be produced by the Irish plant, including polypropylene.

Westcoast Transmission Co., Ltd., will build a gas processing plant on a 200-acre site four miles east of the Alberta-British Columbia boundary in Canada. Canadian Bechtel, Ltd., will be in charge of project engineering and construction.

E. I. duPont de Nemours Co. has opened a plant in Northern Ireland to produce neoprene synthetic rubber. Although the unit was designed for production of 50 million pounds per year, plans for a 20 percent increase have been made.

Standard Oil Co. (Indiana) has withdrawn from negotiations with the Thai government to build a refinery in Thailand. The company said a detailed cost analysis indicated the project was not economically attractive.

British Petroleum Co. and Shell Oil Co. will build a refinery in Nigeria. The plant, which will be built in the Port Harcourt area, will process about 20,000 bpd of Nigerian crude oil. Construction cost of the refinery is estimated at $33,600,000. It will be the first refinery in Nigeria to process Nigerian crude into refined products for the Nigeran market.

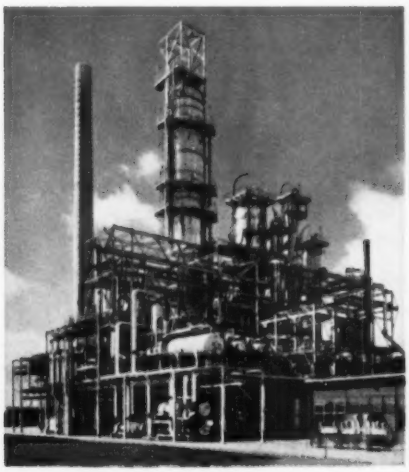
ENI has signed an agreement with the Ghana government under which ENI will build a 24,000-bpd refinery near Tema, Ghana. Capacity of the $20-million project will ultimately be increased to 40,000 bpd.

Foster Wheeler Corp. has cancelled a contract with the Indonesian government to build a $30-million fertilizer plant in Sumatra.

POINT OF PRIDE

Stone & Webster engineers are justifiably proud of the successful process plants they have designed and constructed around the world. Each adds his full measure of skill and experience to the deep well of knowledge and ability that Stone & Webster can bring to your next process project.

We would welcome the opportunity to discuss how we might help you.



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REMEMBER COLLAR BUTTONS?

NOW **PARKER** HAS ELIMINATED A MORE SERIOUS ANNOYANCE ...LOST TUBE FITTING FERRULES!

A simple change in the design of Parker "Intru-lok®," the positive, bite-type Parker fitting for copper, aluminum or plastic tubing, has solved an age-old problem.

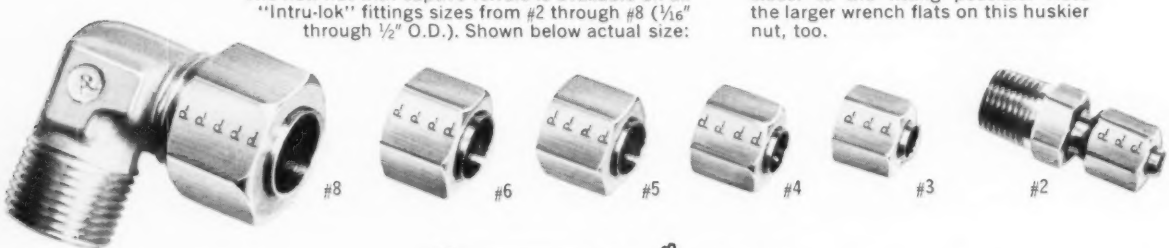
Small three- and four-piece tube fittings have long been a pain in the neck on applications where it is necessary to remove the nut from the fitting. The ferrule(s) fall out and promptly disappear. If and when found, they often get put in backwards. Sometimes they never get put back at all. Result, in either case: a leaking joint.

Now Parker has developed a snap-in, captive ferrule for "Intru-lok." You can take it out of the nut, "on purpose," but you can't drop it out accidentally.

You get all the leakproof safety of a three-piece fitting with positive "bite." You also get the convenience, the quick, easy assembly of a two-piece fitting. The easiest fitting to install has been made even easier. Write for new "Intru-lok" dimensions and prices today.

Three "detents" hold the "tail" of the new ferrule in the nut. Also, the larger hole in the nut makes tube bends closer to the fitting possible. Note the larger wrench flats on this huskier nut, too.

The new nut with captive ferrule is available on all "Intru-lok" fittings sizes from #2 through #8 (1/16" through 1/2" O.D.). Shown below actual size:



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New Books...

As selected by the editors of PETROLEUM REFINER

Unfired Pressure Vessels

"Unfired Pressure Vessels: The ASME Code Simplified" includes 66 tables, charts and diagrams permitting quick, accurate calculations for designing, ordering, fabricating, inspecting and repairing unfired pressure vessels. It is a practical workbook for consulting mechanical, chemical and design engineers, and for fabricators, inspectors, shop supervisors and users of code vessels.

The fourth edition has been enlarged, revised, and updated to include current requirements of Section VIII Rules for Construction of Unfired Pressure Vessels, and of Section IX on Welding Qualifications of the ASME Boiler and Pressure Vessel Code. Written in an easy-to-understand manner, this compact book brings in condensed form all the useful information gained by the author in 24 years of evaluating ASME code design as an inspector for an inspection and insurance company.

(Chuse, Robert, *Unfired Pressure Vessels: The ASME Code Simplified,* F. W. Dodge Corp., 119 West 40th St., New York 18, N.Y., 154 pages, $8.75.)

Mineral Statistics

"Historical Statistics of Minerals in the United States" is a reprint of the Minerals Chapter of *Historical Statistics of the United States—Colonial Times to 1957,* published in 1960.

Among the tables presented are those which give: Value of Mineral Products, in Current Dollars: 1880 to 1956; Value of mineral Production, Imports, and Exports in Constant Dollars: Indexes of Mineral Production; Crude Petroleum—Production, Value at Well, Vented and Proved Reserves; Natural Gas—Marketed Production, Values at Well, Vented and Wasted, Repressuring, Proved Reserves, and Consumption; Natural Gas Liquids—Production and Value; Input and Output of Petroleum Products at Refineries; and Petroleum Products—Imports and Exports.

(Schurr, Sam H.; Vogely, Elizabeth K., *Historical Statistics of Minerals in the United States,* Resources for the Future, Inc., 1775 Massachusetts Ave., N. W., Washington, D. C., 42 pages, $1.)

Showmanship in Safety

"Showmanship in Safety" is a second edition of a new book which has gained great popularity with safety men. It contains ideas for meetings, contests, displays, stunts, quizzes, publicity and demonstrations to add interest, originality and favorable employe reaction to a safety program.

The edition offers such effective ideas as The Safety Bingo Game, The Teaser Button, The Prizerama, Safety Trading Stamps and many other interest rousers.

(*Showmanship in Safety,* National Safety Council, 425 North Michigan Ave., Chicago 11, Ill., 94 pages, $2.20.)

Deep Treasure

"The Deep Treasure" tells of experiences in the vigorous and violent oil country of the Southwestern United States. The author relates stories of the strangely assorted people he knew and of the highly charged life they led in the tense atmosphere of the search for treasure. Geologists, engineers, drillers, ranchers, farmers, field hands, bankers, brokers, easy women, Mexicans, soldiers, bandits, all play their roles in the high drama.

(Williamson, J. C., *The Deep Treasure,* Crown Publishers, Inc., 419 Park Ave. South, New York 16, N.Y., 208 pages, $3.50.)

Perchlorates

"Perchlorates: Their Properties, Manufacture and Uses" brings together in one volume what is known of the technology of perchlorates and perchloric acid. Leading authorities in the field trace the commercial development of the perchlorate industry on a worldwide scale, review the properties and the manufacture of the compounds, and examine their various uses.

Aside from its immediate value as an accurate reference for present day problems encountered in the manufacture and use of perchlorates and perchloric acid, this book provides the background for future research and development in this expanding field.

(Schumacher, Joseph C., *Perchlorates: Their Properties, Manufacture and Uses,* Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 256 pages, $8.75. For sale by Gulf Publishing Co., P.O. Box 2608, Houston 1, Texas.)

Chemistry of Propellants

"The Chemistry of Propellants" contains the authoritative papers presented and the discussions which followed them at a meeting organized by the Advisory Group for Aeronautical Research and Development combustion and propulsion panel in Paris. The papers are arranged according to the following topical scheme: propellant sources and costs, liquid propellants, solid propellants, propellants for air-breathing engines, selected basic studies, and discussions on basic problems in propulsion. The prepared comments and informal discussions have been grouped according to the same topical selection as the invited papers.

(Penner, S. S.; Ducarme, J., *The Chemistry of Propellants,* Pergamon Press, 122 East 55th St., New York 22, N.Y., 651 pages, $10.)

Fuel Cells

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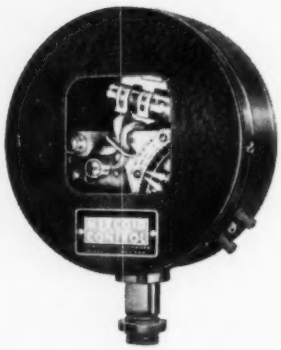

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the Gas and Fuel Division of the American Chemical Society, the book covers the design and principles of operation of various types of fuel cells. The contributing authors examine the industrial implications of fuel cells as ground power supplies, as power supplies for mobile engines, and as chemical reactors. Avoiding the popularized speculative approach to their possible applications, the book provides an accurate, scientifically sound analysis of where and how fuel cells can be applied at present and when and under what conditions they may be employed in the future.

(Young, George, J., *Fuel Cells,* Reinhold Publishing Co., 430 Park Ave., New York 22, N.Y. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, 154 pages, $5.75.)

Compensation Decisions

"Industrial Compensation Decisions" presents a condensed version of workmen's compensation cases completely cross-indexed for easy reference. These cases are the most important that have appeared over the last five years.

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- Making the claim.
- Conflicts—law and insurance.

(Gonda, Richard F.; Marsh, J. Arlen; Louis, Ivan W.; *Industrial Compensation Decisions,* Occupational Hazards Magazine, Industrial Publishing Corp., 812 Huron Road, Cleveland 15, Ohio, 491 pages, $12.50.)

Instrument Installation

"Manual on Installation of Refinery Instruments and Control Systems" covers the installation of the more generally used measurement and control instruments and related accessories in refineries. The manual contains 136 illustrations.

(*Manual on Installation of Refinery Instruments and Control Systems,* American Petroleum Institute, Publications Section, 1271 Avenue of the Americas, New York 20, N. Y., 107 pages, $4.)

Research as a Science

"Research as a Science—Zetetics" outlines a new term for the science of research, zetetics. The paper-backed book is the result of years of study, investigation, and writing on the present knowledge of research, whatever its subject matter.

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The author emphasizes his aim to establish a basis for the collection and systematization of all information about research itself, including the creative process. He states that this knowledge leads to discoveries, inventions, and the solution of human problems.

(Tykociner, J. T., *Research as a Science—Zetetics,* Office of Publications, 114 Civil Engineering Hall, University of Illinois, Urbana, Ill., 205 pages, $2.)

Dynamic Response Testing

"ISA-RP 26.2, Devices with Pneumatic Output Signals" and ISA-RP 26.3, Devices with Electric Output Signals" are two of five recommended practices concerned with dynamic response testing of process control instruments. The two booklets are based on recommendations contained in ISA-RP 26.1, issued in December 1957.

Specific load configurations and test signals for dynamic testing of pneumatic and electric process control instruments are contained in these latest RP's. Also included are recommendations for optional dynamic tests which will characterize the reset and derivative functions of pneumatic and electric controllers.

(*ISA-RP 26.2, Devices with Pneumatic Output Signals, ISA-RP 26.3, Devices with Electric Output Signals,* Instrument Society of America, Technical Publications Department, 313 Sixth Ave., Pittsburgh 22, Pa., 8 pages each, 50¢ to ISA members, 75¢ to non-members.)

Engineering Faculties

"Chemical Engineering Faculties" lists information for over 135 schools in the United States and Canada, such as whether the Chemical Engineering Department is accredited or not, types of graduate work offered, the degrees granted in 1959-60, the names and degrees of the departmental faculty, and the name of the placement officer.

(*Chemical Engineering Faculties,* American Institute of Chemical Engineers, Chemical Engineering Education Projects Committee, Office of the Executive Secretary, 25 West 45th St., New York 36, N. Y., 68 Pages, $3. Free to AIChE members.)

Hydraulic Standards

"Standards of the Hydraulic Institute —10th Edition," is available as a revised supplement to present owners of the book. These revised pages are printed on colored stock, and their insertion in the original loose-leaf cover will bring the entire book completely up to date.

(*Standards of the Hydraulic Institute —10th Edition,* Hydraulic Institute, 122 East 42nd St., New York 17, N. Y., 75 pages, $1.25.)

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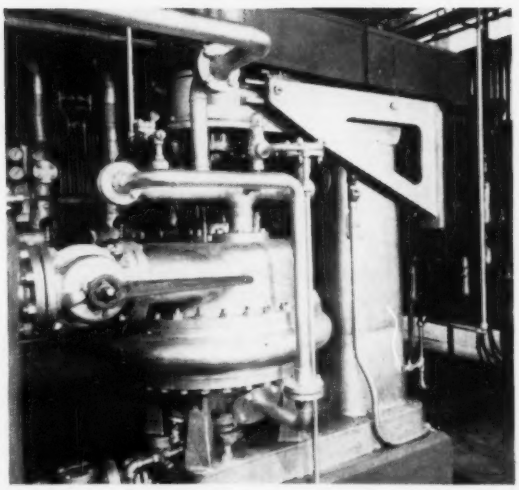

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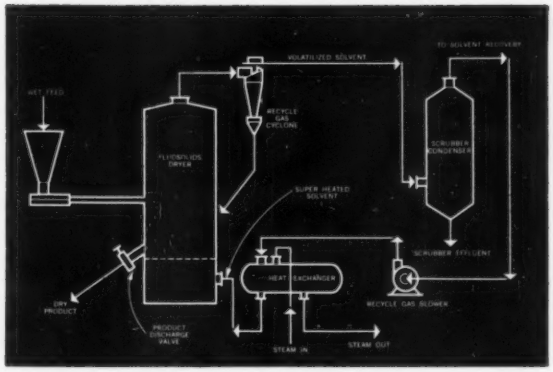

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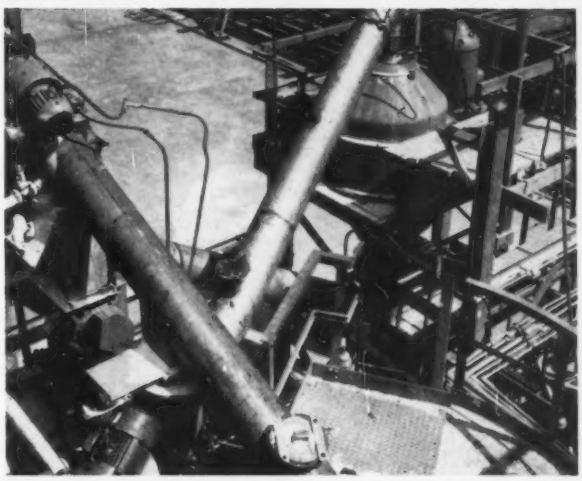

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API Refiners to Meet in Houston

Plant stream analyzers, automotive research, corrosion and fundamental research will be featured

The program for the 26th midyear meeting of the API Division of Refining, scheduled for Houston, has been outlined and refiners attending can look for an outstanding schedule of sessions with well-presented material.

The meeting, which will run from May 8-11, will hold all of its preliminary program and committee meetings in the Rice Hotel. Included on the program are group sessions on plant stream analyzers, corrosion, automotive research, pumps, compressors, and turbines, operating practices, fundamental research, and processes.

A list of topics and sessions follows:

PLANT STREAM ANALYZERS

Presiding: C. H. Thayer, Sun Oil Co., Philadelphia, Pa.

(Session developed by E. B. Kretzmer, Esso Research and Engineering Co., Madison, N. J.; and E. T. Scafe, Socony Mobil Oil Co., Inc., Paulsboro, N. J.)

Keynote Address: Importance of Development and Effective Utilization of Refinery Plant Stream Analyzers.

1. Ten Years of Experience with Process Monitoring Instruments. (S. F. Kapff and R. B. Jacobs, American Oil Co., Whiting, Ind.)

2. Liquid Sampling Process Gas Chromotographs. (C. J. Penther and J. W. Hickling, Shell Development Co., Emeryville, Calif.)

3. Getting the Most Out of Process Analyzers. (C. M. Tyler and R. W. Serne, The Standard Oil Co. (Ohio), Cleveland, Ohio.)

PLANT STREAM ANALYZERS

(Second Session)

Presiding:

(Session developed by E. B. Kretzmer and E. T. Scafe.)

1. Chromatography Can Increase Your Alkylation Efficiency. (J. H. Williams, Jr., and R. L. Wilt, Gulf Oil Corp., Philadelphia, Pa.)

2. Measurement of Trace Water in Refinery Streams. (R. C. Halter and L. M. Johnson, Humble Oil and Refining Co., Baytown, Texas.)

3. Comparison of Performance of Plant Stream Distillation Analyzers with Laboratory Results. (C. K. Donnell, Sun Oil Co., Marcus Hook, Pa.)

4. More Application Engineering: Key to Better Process Control. (D. M. Boyd, Jr., Universal Oil Products Co., Des Plaines, Ill.)

AUTOMOTIVE RESEARCH

Presiding: Henry Flynn, Texaco, Inc., New York, N. Y.

(Session developed by T. B. Rendel, Shell Oil Co., New York, N. Y.)

1. Automotive Trends in a Changing Market. (Victor G. Raviolo, Ford Motor Co., Dearborn, Mich.)

2. The Fuel Cell: Its Promise and Problems. (W. J. Sweeney, Esso Research and Engineering Co., Linden, N. J.)

CORROSION

Presiding: L. R. Goldsmith, Shell Oil Co., New York, N. Y.)

(Session developed by W. A. Bonner, Shell Oil Co., New York, N. Y.)

1. The Rate of Irreversible Hydrogen Attack of Steel at Elevated Temperatures. (P. C. Rosenthal and F. H. Vitovec, University of Wisconsin, Madison, Wis.)

2. Laboratory Tests to Evaluate Corrosion Resistance to Sulfidic Media. (A. S. Couper, American Oil Co., Whiting, Ind.)

3. Hydrogen Sulfide Corrosion Experience in a Distilling Unit. (G. R. Port, Shell Oil Co., Wood River, Ill.)

4. Sulfide Corrosion in a Fluid Coking Unit. (K. L. Moore, Tidewater Oil Co., Delaware City, Del.)

PUMPS, COMPRESSORS, AND TURBINES

Presiding: P. N. Gammelgard, The Pure Oil Co., Chicago, Ill.

(Session developed by J. G. Housman, American Oil Co., Whiting, Ind.)

Theme: Pumps, Compressors, and Turbines for Refineries.

1. The Refiner's Viewpoint. (W. D. Allison, Humble Oil and Refining Co., Baytown, Texas.)

2. The Contractor's Viewpoint. (R. N. Hancock, Foster Wheeler Corp., New York, N. Y.)

3. The Manufacturer's Viewpoint: Pumps—L. H. Garnar, Worthington Corp., Harrison, N. J. Compressors—T. P. Latimer, Clark Brothers Co., Olean N. Y. Turbines—J. R. Siekert, Murray Iron Works, Burlington, Iowa.

TRAINING

Presiding: B. F. Babin, American Oil Co., Texas City, Texas.

(Session developed by D. R. Johnson, Continental Oil Co., Houston, Texas.)

1. A Realistic Approach to Management Development. (H. J. Levitt, Carnegie Institute of Technology, Pittsburgh, Pa.)

2. Also, a paper on Process Training Simulators or Employe Selection.

OPERATING PRACTICES

Presiding: H. W. Ferguson, Humble Oil and Refining Co., Houston, Texas.

(Session developed by J. J. Coates, Esso Standard, Division of Humble Oil and Refining Co., Pittsburgh, Pa.)

1. Safe Operations Through Committee Action. (J. N. Kayser and R. W. Williams, Esso Standard, Division of Humble Oil and Refining Co., Baton Rouge, La.)

2. Safe Operation of Flares. (W. C. Bluhm, Shell Oil Co., New York, N. Y.)

3. Safe Operation of Spheres. (H. T. Fuller, Mobil Oil Co., Beaumont, Texas.)

FUNDAMENTAL RESEARCH

Presiding: E. D. Reeves, Humble Oil and Refining Co., Houston, Texas.

(Session developed by W. D. Seyfried, Humble Oil and Refining Co., Houston, Texas.)

(Sponsored by the Advisory Committee on Fundamental Research on Occurrence and Recovery of Petroleum.)

1. Investigation of Highly Reactive Species by the Matrix Isolation Technique. (G. C. Pimentel, University of California, Berkeley, Calif.)

2. Hydrocarbons as Van Der Waals Liquids. (J. A. Dixon, The Pennsylvania State University, University Park, Pa.)

3. Reaction of Molecular Structure to Fragmentation of Some Sulfur Compounds in the Mass Spectrometer. (Glen Cook, Bureau of Mines, Laramie, Wyo.; and Norman Foster, Bureau of Mines, Bartlesville, Okla.)

4. Reaction of Alkali Metal Salts of Pyrrole with Allylic-Type Halides: A Study of the Factors Influencing the Position of Attack by Ambient Ions in Displacement Reactions. (C. A. Vander Werf, University of Kansas, Lawrence, Kans.)

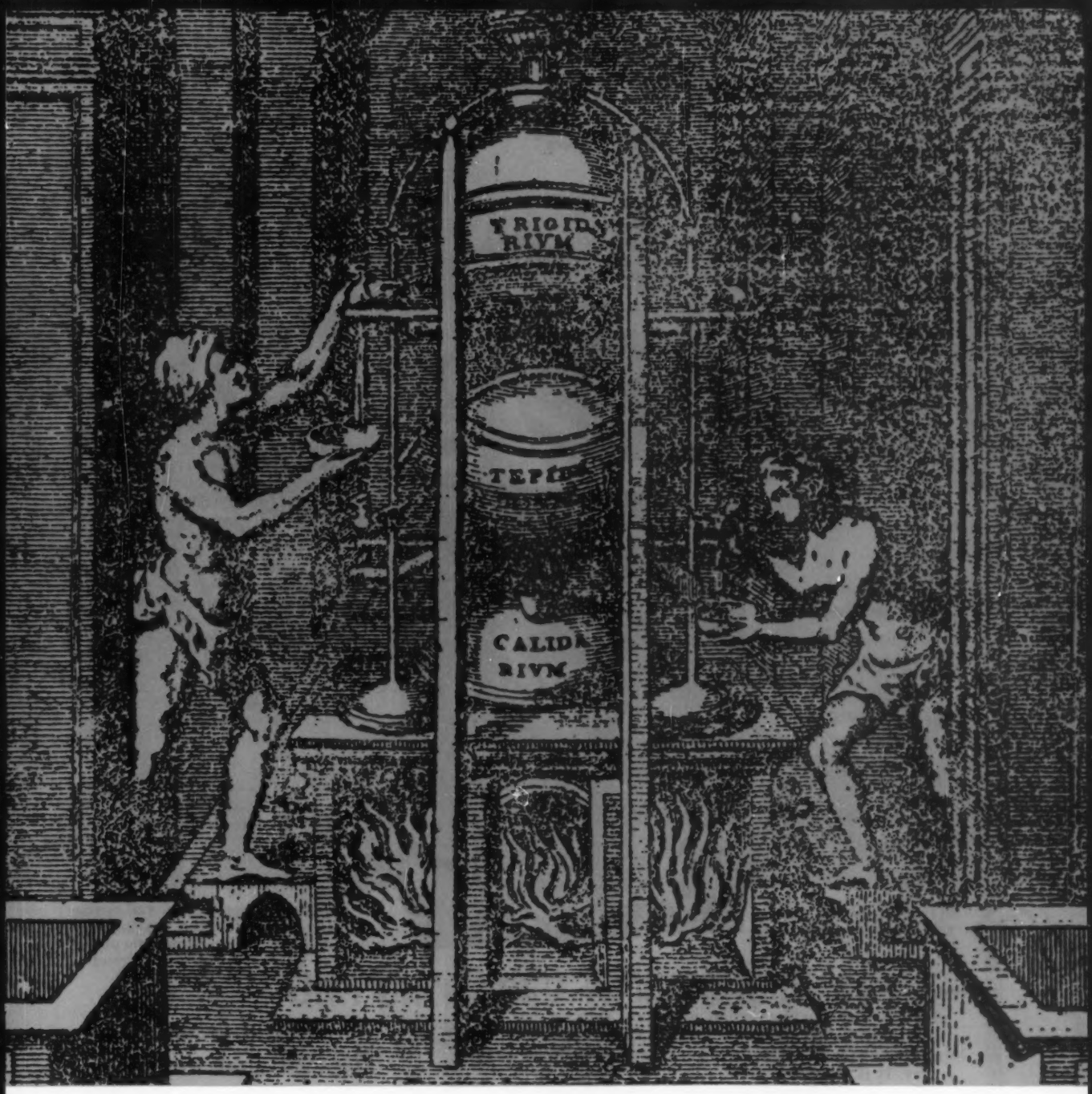
PROCESSES

Presiding: F. P. Sewell, Delhi-Taylor Oil Corp., Dallas, Texas.

(Session developed by F. C. Moriarty, Aurora Gasoline Co., Detroit, Mich.)

1. Production of High Boiling Normal Paraffins from Petroleum. (D. B. Broughton and A. G. Lickus, Universal Oil Products Co., Des Plaines, Ill.)

2. The Gulf HDS Process. (Gulf Oil Corp.)



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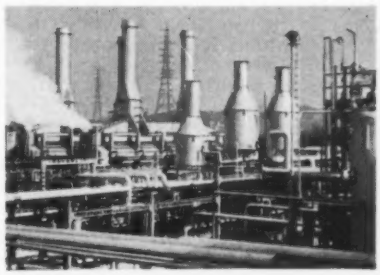

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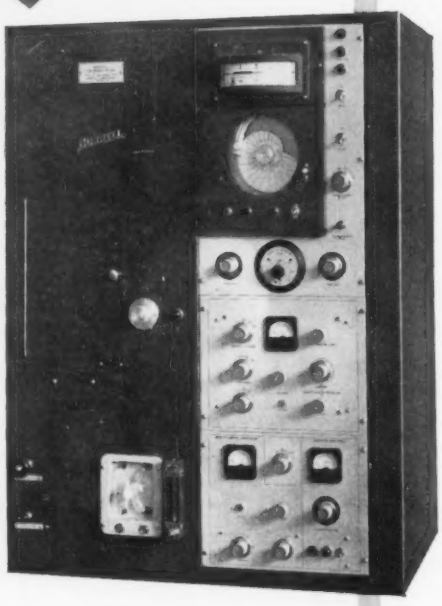

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Happenings . . .

October Crude Output Below September Average

Production of crude petroleum in the United States averaged 6,958,000 bpd in October, a decrease of 13,000 bpd from the September average of 6,971,000 barrels, reports the Bureau of Mines, U.S. Department of the Interior. Compared with September, daily average crude production in October was down 71,000 barrels in Texas and 13,000 barrels in Utah, while Louisiana and Oklahoma reported increases of 49,000 and 16,000 bpd, respectively.

The indicated demand for all crude oil in October decreased 192,000 bpd, comprising a decrease of 175,000 bpd for domestic crude and 17,000 bpd for foreign crude. Total crude stocks, domestic and foreign, amounted to 232,990,000 barrels on October 31, compared with 231,966,000 barrels at the end of September, an increase of 1,024,000 barrels.

Total crude runs to stills in October averaged 7,908,000 bpd, compared with 8,100,000 bpd in September. During the month runs of both domestic and foreign crude were down by 177,000 and 15,000 bpd, respectively.

Stocks of refined products at the end of October amounted to 561,891,000 barrels, an increase of 12,873,000 barrels during the month and 4,399,000 barrels above the level of stocks reported for October 31, 1959.

Total demand for all oils in October was 9,145,000 bpd, including domestic demand amounting to 8,951,000 bpd and exports of 194,000 bpd. Compared with October 1959, this represented a 2.7 percent increase in total demand and a 3.0 percent increase in domestic demand.

The total crude oil capacity of operating refineries in October was 9,731,000 bpd, indicating an operating ratio of 81.3 percent, compared with 83.5 percent in September.

'Project C 8' Promises New Petrochemicals Products

A research breakthrough in the field of pertochemicals which promises to yield a host of new products from plastics and nylons to lubricants and paints has been announced by Dr. H. L. Malakoff, vice president of Cities Service Research and Development Co.

Known as "Project C 8," the new family of petrochemicals—which has never been commercially available before—is expected to have a major impact on the chemical, petroleum and petrochemicals industries.

Dr. Malakoff said Cities Service now is putting limited drum quantities of the new petrochemicals into the hands of plastics and chemicals manufacturers for product evaluation and development work. These new materials include such polysyllabic compounds as cycloocta-

For more data on advertised products, use Readers' Service Cards, last page.

Coming Soon—Weed Control Time

The Tidewater Oil Company obtained excellent weed control around storage tanks at their Delaware Refinery by spraying Du Pont Karmex® and Du Pont Trysben® 200. The area was sprayed in the fall of '59—the photograph taken early fall of '60.

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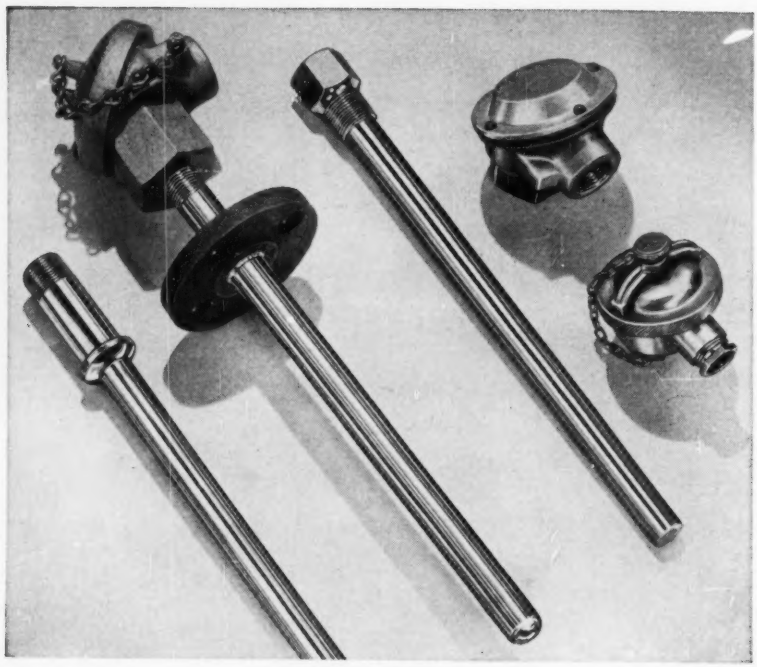

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Thermo Electric's base metal thermocouple assemblies give consistently reliable temperature readings for ranges between —300°F. and +2200°F. We specialize in solving problems caused by chemical attack, pressure and installation difficulties . . . and offer the most complete variety of standard thermocouple assemblies in the industry. See our new 16 page catalog for the many types available.

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Single and multiple junction thermocouples are made of all standard thermocouple materials and gage sizes. Ceramic insulated, metal sheathed "Ceramo-Couples" are used most effectively for extended life at high temperatures or for sub-zero conditions where condensation is a problem. These temperature sensing elements have excellent resistance to moisture, petroleum products, chemical action and abrasion, and are often used without additional protection tubes. The wires used in all these thermocouples are drawn, annealed, insulated and calibrated in our own wire mill under Thermo Electric's high standards for mechanical and thermoelectric qualities.

Thermowells

The selection of over 5700 standard Thermowells includes bar stock or built-up construction, test wells and extra sensitive wells; and a variety of mounting fittings and flanges. Many construction materials available—all wells are pressure tested.

Connection Heads

Choose from six different types, including heavy duty cast iron heads, lightweight aluminum heads, and quick-opening heads. All weather proof—many sizes.

Write For New Catalog E-19

Our Thermocouple Catalog has complete information, simplified ordering instructions for all assemblies and components, and a Thermowell Material Guide for hundreds of industrial applications.

Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY

In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

Happenings . . .

diene, cyclooctene an dcyclooctane.

He said the expectation is that the anticipated consumer and industrial end-products that would be made from the new petrochemicals will be brought out during the next few years. These end-products could include such things as new types of molded plastics and nylon fabrics, high-quality adhesives and coating materials, improved synthetic lubricants and high-energy fuels.

At the present time, he explained, Cities Service does not plan to enter into production of such end-products but plans to assume the role of supplier of the new intermediates to chemical and plastic manufacturers.

Key to the petrochemicals breakthrough, which culminated years of research into the development of new and better products from butadiene, was the development by Cities Service's scientists of two new catalysts. Details of the composition and application of the catalysts are being withheld pending patent applications.

U.S. November Imports See Increase Over '59 Figure

Imports into the continental United States during November increased from 1,719,000 bpd in November 1959 to 1,879,000 bpd, reports from the U.S. Census Bureau show. Crude imports averaged 1,028,000 bpd this year compared with 916,000 bpd in the same period last year.

Residual imports this year hit an average of 708,000 bpd in comparison to last year's 686,000 bpd.

Shell Oil Asphalt Is Successful on Airstrip

The problem of maintaining pavements burdened by gaint jet planes is being attacked with a new type of asphalt at the Pacific Missile Range Headquarters, Point Mugu, Calif. Some 40,000 square feet of jet aircraft area was paved recently with Shell Oil Co.'s Epon Resin asphalt concrete.

Conventional asphalt cracked and pitted from daily use by the Navy's jet planes—caused by jet fuels, solvents and other liquids and the intense heat blasts and weight of the planes. The new material, proven successful at other locations in preventing such damage, consists of an asphalt base mixed with Epon Resin and Epon asphalt plastic additive.

Oilmen Will Offer Support To National Energy Program

Oil and gas industry representatives have indicated that they will cooperate in any federal study or formulation of policy on a national energy program.

For more data on advertised products, use Readers' Service Cards, last page.

see you there

at the A.I.Ch.E. Petrochemical and Refining Show...

the place: ▲
NEW ORLEANS, LA.
the time: ▼

FEBRUARY 1961

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

the reason: ▶

The First Annual Petrochemical and Refining Show February 26th through March 1st, 1961 — Sponsored by The American Institute of Chemical Engineers — The B-I-G Thing in This Important Field for 1961.

Be Sure That You Don't Miss It — Make Your Reservations *Today!*

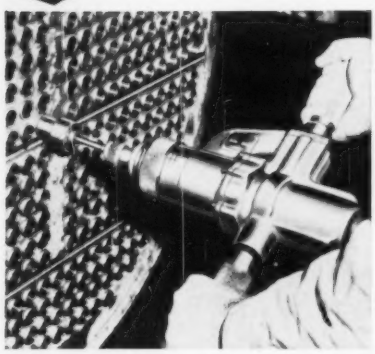
For Further Information Contact:

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS
25 West 45th Street, New York 36, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

AIRETOOL

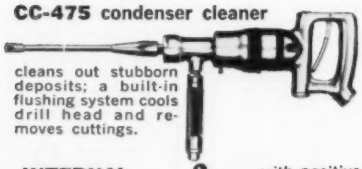
job-fitted pneumatic tools for better tube maintenance . . .



Proper tube fabrication and maintenance depend on the right equipment for each job. And Airetool's complete line of air-powered tools and accessories are job-fitted to specific needs; to cut down time, boost in-service life and speed tube repair and replacement.

AIRETROL (illustrated above). Positive, automatic tube expansion control that's accurate within .001 inch. Rolls up to 12 tubes a minute.

CC-475 condenser cleaner



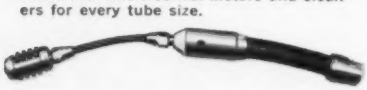
cleans out stubborn deposits; a built-in flushing system cools drill head and removes cuttings.

INTERNAL TUBE CUTTER

with positive feed control for cutting tubes of 12 to 20 gauge.

EXPANDING BRUSH HEAD CLEANER

with flexible shaft and universal joint for tubes with short bends. Motors and cleaners for every tube size.



For further information, write:

AIRETOOL MANUFACTURING COMPANY
SPRINGFIELD, OHIO

Branch Offices: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge
Representatives in principal cities of U. S. A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii
European Plant: Vlaardingen, The Netherlands
Canadian Plant: Brantford, Ontario

Happenings . . .

The oilmen, who met in Washington, D.C., at a strategy session on fuels policy, frowned on the coal interests' efforts to push a national energy policy that might result in a federal control over the fuels market competition.

The oil and gas delegates stated that they would not resist any moves by the new administration to coordinate federal energy policies, but would fight against any attempt by one ailing industry to seek federal aid in continuing uneconomic operations at the expense of successful, low-cost competitors.

'Closed-loop' Computer Will Control Gulf Cat Cracker

The first known use of closed-loop automatic computer control of a catalytic cracking unit will be instituted at Gulf Oil Corp's Philadelphia refinery early this year.

One of the larger fluid catalytic cracking units in the country, Gulf's 60,000-bpd unit at Philadelphia will be controlled by a digital computer.

Closed-loop computer control is a system through which significant variables are automatically controlled, usually at some optimum value, by a computer on the basis of operating measurements automatically fed into it.

Gulf engineers and scientists began looking at the possibilities for the application of computer control to refining processes some two years ago, and since October 1959 have been working on an intensive process and programming analysis.

The results of this joint study have shown that the use of the computer will increase operating efficiency of the cat cracker up to 95 percent of theoretical perfection primarily by controlling more closely two major process variables—reactor temperature and re-cycle ratio.

Principal products of the cat cracker at Philadelphia are high octane gasoline stocks, liquid butanes, liquid propanes, and household and industrial fuel oils.

New Trend in Computers Forecast for 1961

A dramatic new trend in the role of computers during 1961 has been forecast by Gilbert E. Jones, president of the Data Processing Division, International Business Machines Corp. "Supplementing their historic record-keeping role, computers will be turning more and more to the job of helping management plan and control a business," Jones said.

The chief executive of IBM's 21,000-man Marketing Division based his prediction on the development, last year, of new products, programs and data communication equipment designed to extend the use of computers to the over-all operation of firms of all sizes.

In the planning and control functions, many firms will employ data processing systems to direct and monitor industrial processes such as the distillation of crude oil. There will be increasing use of computer-based techniques for the design

FOR A *SAFE AND EFFICIENT* ACCESS TO THE TOP OF ANY SIZE CAR . . .
IT'S THE ADJUSTABLE "HEMCO GANGWAY"

OFFERING THESE IMPORTANT FEATURES:

- GIVES LEVEL WALK OUT TO JUMBO CARS OR TRUCKS, OR SMALL CARS OR TRUCKS
- TELESCOPES TO REACH ANY TYPE CAR
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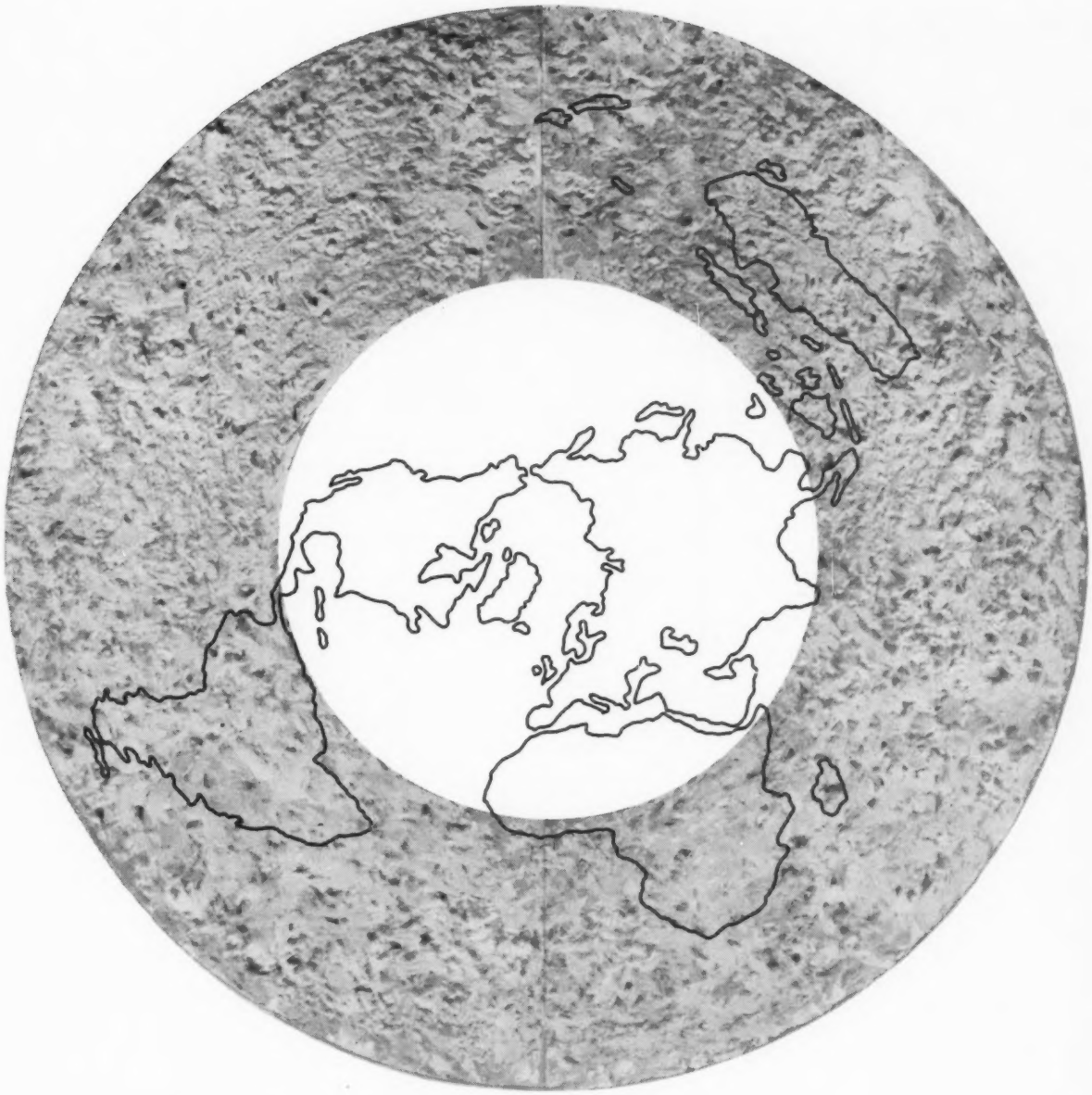

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—and to the same specification

Caposite amosite asbestos is manufactured under supervision to the same uniform specification in all these countries.

Great Britain	by Cape Insulation & Asbestos Products Ltd.
Canada	by Caposite Insulations Ltd
South Africa	by Cape Asbestos Insulations (Pty) Ltd
Australia	by James Hardie & Company Ltd
France (as 'Isolamiante')	by Isolamiante SA
Italy	by Capamianto SpA
Holland	by J. de Boer & Company
Spain	by Messrs. Eduardo Rosa
Argentina	by Montisol Argentina, SRL
Japan	by Nippon Asbestos Company

Amosite asbestos insulation is also manufactured in U.S.A. under the name of 'Unibestos' by Union Asbestos Rubber Company.

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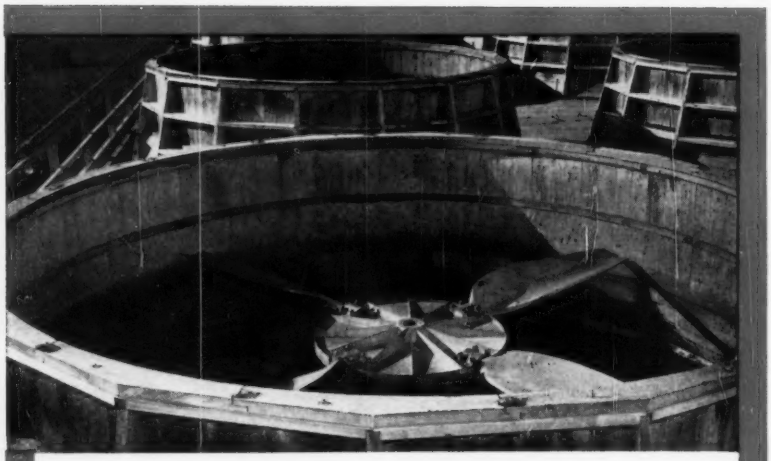
TA.3612



HARTZELL Reports . . . on dependable Water Cooling for Houston power station

Operating: 6 years

Performance: Trouble-free

Service: Low cost maintenance

These facts sum up the reliability and economy of Hartzell 14-foot Adjustable Pitch fan assemblies now operating at Houston Lighting and Power Company's Hiram O. Clarke station.

Of a total of 60 fans operating on this large induced draft tower that cools circulating water for power generation, a majority are Hartzell type "P," molded plastic model, which have provided trouble-free, low cost maintenance operation since 1954.

One important reason for the high quality of performance of Hartzell fans on this and thousands of other installations is the use of exclusive Hartzite plastic. This material far exceeds other blade materials in its ability to resist corrosion, abrasion and vibration.

Write for all the facts . . . or, better yet, let a Hartzell representative show you how a Hartzell fan will make "dollars and sense" in your cooling tower and heat exchanger operations.

HARTZELL PROPELLER FAN CO.

Engineering Offices in Principal Cities

Div. of Castle Hills Corp. Piqua, Ohio

Happenings . . .

and manufacture of machine tools.

In the management area, IBM's management operating system, introduced last year, is able to develop product plans, plan the requisition and distribution of materials, manage inventories, supervise scheduling and dispatching, and evaluate the production cycle in a continuous system with a minimum of human intervention.

The improvement in data communications ties in closely with the planning and operating functions of management by expediting the transmission of data that is needed by company executives to make effective top-level decisions.

IPAA Reports Drop in Oil Demand for Fourth Quarter

Oil demands fell 210,000 bpd short of expectations in the fourth quarter of 1960, due partly to "declining industrial activity," according to the Independent Petroleum Association of America.

Fourth quarter consumption of heavy fuel oil, primarily by industry, was 100,000 bpd below the same period a year ago, and 90,000 barrels less than IPAA's Supply and Demand Committee had forecast last October.

In its January Supply and Demand Outlook, IPAA said total fourth quarter demand of 10,140,000 bpd, for all petroleum products, was only 1.5 percent above the same period in 1959.

The association said the outlook for the next three months February through April, indicates total demand for all products will be 10,220,000 bpd—165,000 barrels or 1.6 percent less than in the same months last year when March was 30 percent colder than normal.

Failure of demand to reach expected levels in the last three months of 1960 left petroleum inventories at the end of December 20 million barrels higher than IPAA's Supply and Demand Committee had anticipated on that date.

Crude oil runs to refineries in the 1960 fourth quarter were 35,000 bpd above the year earlier period, and if demands in the next three months go as expected, refinery runs of 8 million bpd "would be adequate" in this period.

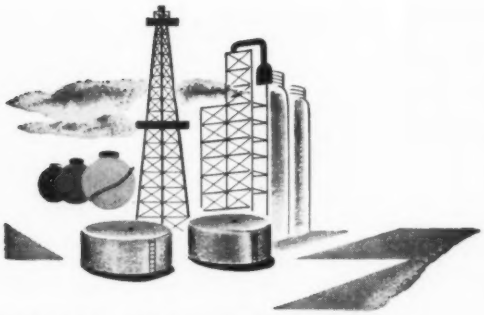
The demand outlook, the inventory situation, and import levels as permitted by the government import program, said IPAA, indicate total production of crude oil and natural gas liquids of 8,150,000 bpd during February-April.

With gas liquids output expected to average 1 million bpd, IPAA said, the market for domestic crude oil will be about 7,150,000 bpd in the next three months, 50,000 barrels less than expected January production of 7,200,000 bpd.

AIChE Exposition Set For February 26 - March 1

Exhibitors, at the record rate of one

For more data on advertised products, use Readers' Service Cards, last page.



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STOP WEEDS

with safe, effective

SIMAZINE or ATRAZINE

pre-emergence pre- or post-emergence

HERBICIDES

Economical, long residual Geigy herbicides save time and money—do the job right the first time. One application stops weeds before they start—gives you season long control.

Safe to humans and animals, non-irritating to skin, non-flammable, non-corrosive to equipment. Safe to use on valuable land. Available through leading distributors.

FREE BROCHURE: *New full color booklet contains complete directions, diagrams, applications and other useful data for both Simazine and Atrazine.*

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Send free weed control brochure to:

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Geigy **ORIGINATORS OF DDT INSECTICIDES**

For more data on advertised products, use Readers' Service Cards, last page.

Unlimited Flexibility!

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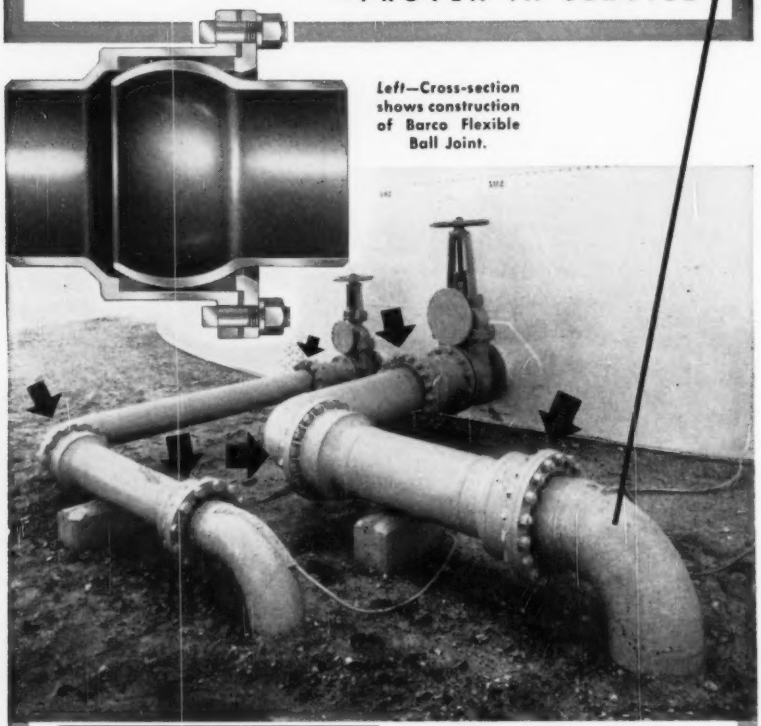
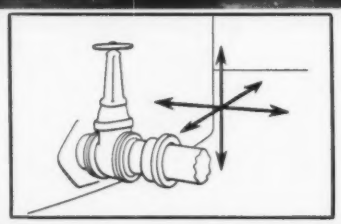


Left—Cross-section shows construction of Barco Flexible Ball Joint.



Allows 6-Way Movement!

Freedom of movement in any direction is readily possible with these *ball joint connections* of 12" pipe (right) and 8" pipe (left) to 80,203 bbl. tank shown in above photo. (Photo: SHELL OIL COMPANY, Dominguez Refinery, Wilmington, Calif.)

Barco Ball Joints—*Fire Safe!*

provide complete protection against FIRE, PIPE EXPANSION, TANK SETTLING

Major oil companies throughout the country now approve the use of Barco's new large size Flexible Ball Joints on tank connections for the following reasons:

1. Fire-safe. The joints have passed rigid fire and water spray tests.
2. Superior for handling pipe expansion—no combustible packing, no thin wall sections, no "end thrust" from pressure, no heavy pipe anchoring required.
3. Complete protection—relieve strain and twisting forces on valve flanges or tank wall.
4. Compact! Ideal for use inside narrow space between fire wall and tank. Easy to design piping for any amount of flexibility desired.
5. Also useful for insulating piping against electrolysis.
6. Long service life without maintenance. No lubrication. Sizes to 16"; flanged or welding ends.

For engineering recommendations, see your nearest Barco representative or write. ASK FOR CATALOG 215B and BULLETIN 31-A.

PRODUCTS BACKED BY EXPERIENCE BARCO FOUNDED 1908

BARCO MANUFACTURING CO.

542C Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints

In Canada: The Holden Co., Ltd., Montreal

Happenings . . .

a day, are reserving space in the nation's first AIChE Petrochemical and Refining Exposition which is set for Feb. 26-March 1, 1961, in Municipal Auditorium, New Orleans, officials report.

The American Institute of Chemical Engineers, sponsors of the event, said that this "unprecedented demand has resulted in more than 70 percent of the space being sold nine weeks after it was made available."

The petrochemical and refinining exposition will be held biennially in conjunction with technical sessions of AIChE. The organization has 20,000 members and 75 affiliated local sections.

The joint event will be the first exposition and conference devoted solely to technological and research problems of the combined petrochemical and petroleum refining industries.

- *Changing Times* -

Petroleum demand in the United States makes 69 percent increase during the 1950's, according to Oil Facts, American Petroleum Institute publication. The book says petroleum presently provides more than 72 percent of the nation's motive and mechanical power.

Grants totaling more than $1,400,000 awarded to 159 universities and colleges in the Du Pont Co.'s annual program of aid to education. The program is basically for education or research in science and engineering.

Society for Experimental Stress Analysis gets $45,000 for three-year period from the National Science Foundation. The money will help set up the society's official journal, Experimental Mechanics.

French crude production is expected to reach 218,000 bpd, compared with 79,000 bpd in 1959, the oil industry's trade association reports. French refinery runs were expected to average 652,000 bpd in 1960, compared with 616,000 bpd in 1959.

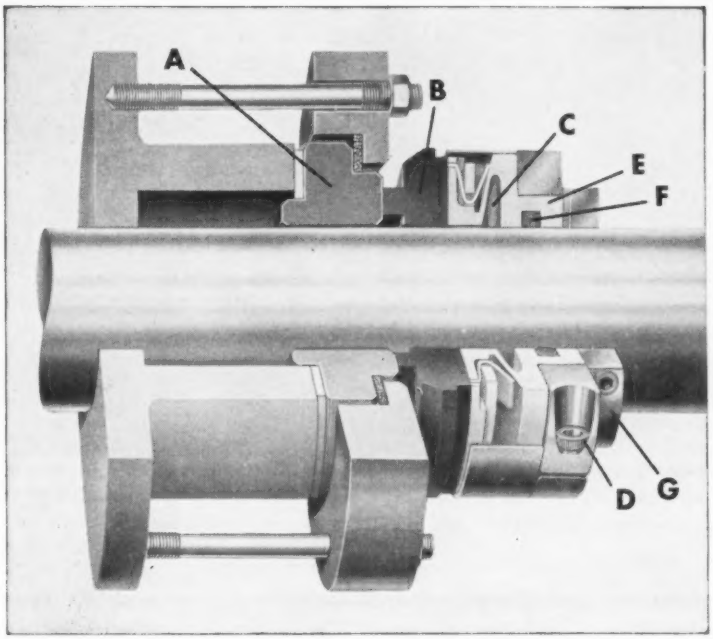
Cities Service Oil Co. changes its name to Cities Service Petroleum Co. Cities Service Petroleum will operate Cities' refineries at East Chicago, Ill., and Ponca City, Okla., which were previously run by Cities Service Oil.

Southwestern Agrochemical Corp., Chandler, Ariz., buys out Kerley Chemical Corp., also of Arizona. Kerley was a manufacturer of insecticides and ammonium polysulfide at Kyrene, Ariz.

A record was set at Tidewater Oil Co.'s Delaware refinery late in December 1960. The plant averaged 159,000 bpd of crude oil during a 723-day run in which some 92,100,000 barrels of crude oil were charged to the unit.

Air pollution research gets $60,000 in

ENGINEERED SEALS
for Petroleum Refining



LAST LONGER IN CORROSIVE CHEMICALS

Garlock CHEMISEAL* Mechanical Seals have, through years of application, proved their ability to seal effectively against all chemicals . . . from the "easier" Methanol, Acetic and Propionic Acids to the more reactive Hydroxyacetic, Sulfuric, Adipic Acids and Hydrocarbon Slurry.

High-quality construction. The bellows unit of CHEMISEAL Mechanical Seals is, in all cases, made of chemically-inert Teflon†. Various materials are used for the sealing faces dependent upon the medium and service requirements. Referring to the illustration at left, the seal comprises a stationary face "A" secured to the stuffing box and a rotary face "B" which rotates with the balance of the seal mechanism and is secured to the shaft. Between these precision lapped faces a leak proof seal is accomplished by the spring loaded Teflon bellows section "C." Clamp "D" secures area "E" to the shaft with the help of the Hypalon or Teflon O-Ring "F," forming a drop-tight seal. Back-up collar "G" is an added precaution to prevent the seal from working out on the shaft.

There are other benefits, too, that CHEMISEAL Mechanical Seals can add to your particular application. Consider the fact that they offer a life expectancy many times that of other seals . . . don't score the shaft during operation . . . are easy to handle and install.

Solve your difficult sealing problems. Apply Garlock CHEMISEAL Mechanical Seals against all media—including solids in suspension—in pressures to 100 psi at 75°C, or 75 psi at 100°C. Standard sizes to fit all pump shafts from $\frac{7}{8}$" to $2\frac{1}{8}$"; special sizes also available. Discuss complete details with your local Garlock representative, or write for Catalog AD-164. Garlock Inc., Palmyra, New York.

GARLOCK

Visit our booths 632-634 at the Petrochemical and Refining Exposition in New Orleans.

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

*Registered Trademark
†DuPont Trademark for TFE Fluorocarbon Resin

THERE'S NO "OR EQUAL" TO DEARBORN'S ENDCOR® FOR COOLING WATER TREATMENT

1. No treatment. 2. Chromate-polyphosphate mixture—50ppm. 3. Chromate-polyphosphate mixture plus Endcor A—50ppm.
Unretouched photographs showing the effect of Endcor A in cooling water treatment at a pH of 6.5 and a temperature of 130° F.

Today, there's more than two years of performance proof behind Dearborn's cooling water treatments with the research developed additive, Endcor.

And today, more and more companies, with millions of dollars worth of cooling systems and equipment to protect, are striking out the "or equal" clause and directly specifying one of these Endcor products.

There's Polychrome ® 501 and 505 with Endcor A . . . Dearborn ® 860 with Endcor B . . . and others —all designed to do specific corrosion and deposit inhibiting jobs more precisely, more effectively, and, in many cases, more economically.

Behind these products are important "pluses," too. There's Dearborn's experience dating back to 1887 —longest in the water treatment field. There's its extensive research facilities . . . its modern, completely equipped laboratories to provide truly scientific answers to specific and baffling problems . . . its Technical Center in Chicago staffed with recognized experts to back up products and Dearborn engineers in the field.

Because of its critical importance to overall results, Dearborn also provides the most complete and effective line of chemical feeding equipment of any water treatment company.

We'll be glad to send you Technical Bulletins on our Endcor products. Or to consult with you on any water treatment problem, without cost or obligation. Call or write us today.

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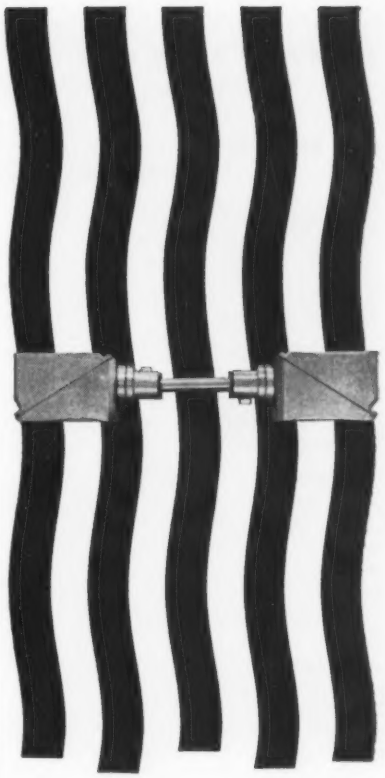
Changing Times (continued)

cash and equipment valued at $45,000 from the Air Pollution Foundation. The Stanford Research Institute, the University of Southern California and the Southwest Research Institute received the money and equipment.

Personnel from the Iranian National Oil Co. are sent to help set up the Venezuelan National Oil Co. The Venezuelan Petrochemical Institute, reports Oil Minister Juan Perez Alfonzo, may obtain technical assistance in programming operations from Ente Nationale Indrocarburi in Italy.

Meetings Calendar

Feb.	
15–16	**Western Petroleum Refiners' Association,** Gulf Coast Regional Technical-Industrial Relations Meeting, Robert Driscoll Hotel, Corpus Christi, Texas.
–24	**Natural Gasoline Association of America,** South Louisiana Regional Meeting, Lafayette Petroleum Club, Lafayette, La.
26–Mar. 1	**American Institute of Chemical Engineers,** Petrochemical and Refining Exposition, Municipal Auditorium, New Orleans, La.
Mar.	
5– 9	**American Society of Mechanical Engineers,** Gas Turbine Power Conference & Exhibit, Shoreham Hotel, Washington, D.C.
13–17	**National Association of Corrosion Engineers,** Annual Meeting & Corrosion Show, Hotel Statler, Buffalo, N.Y.
15–17	**NGAA,** Annual Convention, The Baker Hotel, Dallas, Texas.
21–23	**American Power Conference,** Sherman Hotel, Chicago, Ill.
21–30	**American Chemical Society,** National Meeting, St. Louis, Mo.
27–31	**Instrument Society of America,** Symposium on Temperature—Its Measurement and Control in Science and Industry, Veterans' Memorial Auditorium, Columbus, Ohio.
28–29	**Gas Conditioning Course,** University of Oklahoma, Norman, Okla.
April	
10–11	**ASME,** Maintenance & Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.
10–12	**WPRA,** Annual Meeting, Grenada Hotel, San Antonio, Texas.
10–14	**Safety Engineering Course,** University of Oklahoma, Norman, Okla.
17–19	**ISA,** National Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, Texas.
18–20	**American Welding Society,** Meeting and Show, Commodore Hotel, New York.
18–20	**Gas Measurement Short Course,** University of Oklahoma, Norman, Okla
–28	**NGAA,** Oklahoma Regional Meeting, Lake Murray Lodge, Ardmore, Okla.
May	
2– 4	**Purdue Industrial Waste Conference,** Purdue Memorial Center, Purdue University, Lafayette, Ind.
8–10	**ISA,** National Power Instrumentation Symposium, LaSalle Hotel, Chicago, Ill.
8–11	**American Petroleum Institute,** Division of Refining, Midyear Meeting, Rice Hotel, Houston, Texas.
8–12	**API,** Accident Prevention and Fire Protection Meetings, Statler-Hilton Hotel, Detroit.
11–13	**American Institute of Industrial Engineers,** National Conference & Convention, Sheraton Cadillac Hotel, Detroit, Mich.
15–19	**National Fire Protection Association,** Annual Meeting, Statler Hotel, Detroit, Mich.
–19	**NGAA,** Permian Basin Regional Meeting, Lincoln Hotel, Odessa, Texas.
22–24	**ISA, AIEE, ARS, IAS, IRE,** National Telemetering Conference, Chicago.
22–25	**ASME,** Design Engineering Conference & Show, Cobo Hall, Detroit, Mich.
23–24	**WPRA,** Mid-Continent Regional Technical-Industrial Relations Meeting, Hotel Lassen, Wichita, Kan.
June	
6– 8	**ISA,** Summer Instrument-Automation Conference & Exhibit, Royal York Hotel, Queen Elizabeth Hall, Toronto, Ont.
–12	**ISA,** Air Pollution Control Association, Air Pollution Instrumentation Symposium, Hotel Commodore, New York City.
12–16	**Technical Writer's Institute,** Rensselaer Polytechnic Institute, Troy, N.Y.
13–16	**ISA,** Gas Chromatography Symposium, Kellogg Center, Michigan State University, East Lansing, Mich.
14–15	**WPRA,** Refiners' Computer Conference, Site and Location Unreported.
28–30	**American Association of Cost Engineers,** Annual Meeting, Boston, Mass.
28–30	**ISA, AIChE, AIEE, ASME, IRE,** Automatic Control Conference, University of Colorado, Boulder, Col.
Sept.	
5– 8	**ACS,** National Chemical Exposition, Chicago Amphitheater, Chicago, Ill.
11–15	**ISA,** Fall Instrument-Automation Conference & Exhibit, Biltmore Hotel, Memorial Sports Arena, Los Angeles, Calif.
–14	**NGAA,** Rocky Mountain Regional Meeting, Northern Hotel, Billings, Mont.



for measuring color in continuous streams

Beckman Model 77 Continuous Turbidimeter-Colorimeter takes the guesswork out of clarity and color determinations...gives rapid, accurate readings to better than ±2% of light transmission. The Model 77 consists of an Analyzer Unit and Control Unit...precision designed and ruggedly constructed to bring colorimetry to continuous process applications. Among the wide range of applications are control of water and industrial waste treatment processes, and colorimetric quality control analyses in the production of chemicals and petroleum. ☒ Outstanding Beckman features are: ±1% repeatability... push-button scale expansion from 0-100% to 0-50% transmittance... wavelength ranges from 350 to 1000 mμ. ☒ Complete information applicable to your specific process is available from your nearest Beckman Sales Office. Or write direct for Data File 25-2-13.

Beckman
Scientific and Process Instruments Division
Beckman Instruments, Inc.
2500 Fullerton Road,
Fullerton, California

For more data on advertised products, use Readers' Service Cards, last page.

Men in HPI...

L. C. Burroughs, presently assistant to the vice president, manufacturing, Shell Oil Co., has accepted an appointment with the American Petroleum Institute as consultant on air and water pollution. Burroughs has been made available to the API on a full-time basis until his retirement from Shell at the end of 1962. He will advise the API on proposed legislation affecting the oil industry having to do with air and water pollution abatement at the municipal, state and federal levels. He will also serve as executive secretary for the API Smoke and Fumes Committee.

Burroughs

J. H. Laws has been named plant superintendent, Industrial Chemicals Division, Shell Chemical Co.'s Houston plant. He succeeds **C. H. Plomteaux,** recently appointed plant manager of the Shell Point, Calif., plant, Ammonia Division. **W. A. Gabig,** formerly assistant chief engineer, maintenance, Industrial Chemicals Division, replaces Laws as assistant superintendent, operations, in the division. **K. F. Behrens,** formerly area engineer of the division at the Norco, La., plant, succeeds Gabig as assistant chief engineer, maintenance.

W. Dow Hamm has been elected a director of The Atlantic Refining Co. He is succeeding **L. A. Sunkel,** who is retiring after 42 years of service.

Alan K. Roebuck has been appointed senior research scientist, Whiting research laboratories, Standard Oil Co. (Indiana). **James L. Wilson** has been named a project chemical engineer at the laboratories. Roebuck joined Standard in 1947, and Wilson came to the company in 1953.

Dr. Ju Chin Chu of the Polytechnic Institute of Brooklyn has been awarded a contract for $70,000 for the year 1960-'61 to do basic fuel cell research for the U.S. Army. A professor of chemical engineeering at the institute, Dr. Chu received the contract from the Army Engineer's Research and Development Office, Ft. Bellevoir, Va. The Army is interested in developing a low-cost fuel cell-operated mobile power unit.

Russell D. Eberly has been promoted to manager of safety in the Central Employe Relations Department, American Oil Co. With the Standard Oil organization for 37 years, Eberly has been assistant manager of safety in the Chicago general office. He joined Standard Oil in 1923 at the Whiting, Ind., refinery, where he advanced to assistant safety director in 1930. He became supervisor of safety and head of the Safety Department at Whiting in 1934. He was transferred to the Chicago general office as assistant manager of safety for Standard in 1946.

J. C. Kelbaugh has been named administrative superintendent of Shell Oil Co.'s Houston Refinery. He replaces **P. E. Keegan,** who has retired. Kelbaugh joined Shell in February 1939, as a service station salesman in the New York Division.

Harrison E. Fischer has been named an associate in the firm Deevy and Shannon, Consulting Engineers, Beaumont, Texas. The firm specializes in providing engineering services to the refining and petrochemical industries. He attended Rice University.

Robert J. Phillips has been named president of Howe-Baker Engineers, Inc., a subsidiary of Nalco Chemical Co., Chicago. He was formerly vice president in charge of engineering for the firm, which specializes in designing electrical equipment used for desalting and distillate treating by the petroleum refining industry. Phillips also served on the PETROLEUM REFINER staff from June 1952 to December 1954, part of which time he was editorial director. **W. L. Altman** was named administrative assistant to the new president. **H. G. Napier** was promoted from process engineer to chief process engineer, and **R. M. Godfrey,** a design engineer, was made chief mechanical engineer for the company.

Phillips

Harold G. Houlton, Thorwell H. Paulsen and William H. Gammon have been assigned new positions in product research and development for Ashland Oil & Refining Co. Houlton has been named coordinator of petrochemical development. Paulsen, an Ashland employe since 1954, and formerly coordinator of research and refining, has been appointed director of research and development. Gammon, formerly senior chemical engineer, and with Ashland since 1955, becomes assistant director of research and development.

Donald L. Connelly, director and senior vice president of Warren Petroleum Co., has been elected president of Mid-Continent Oil & Gas Association. Connelly replaces **W. J. Goldston,** a Houston independent.

Rudolph Cubicciotti has been promoted to administrative vice president, Witco Chemical Co., Inc. Cubicciotti will direct planning and coordination in all Witco divisions, including Sonneborn Chemical and Refining Corp., Ultra Chemical Works, Inc., and Witco's tar products and pioneer products divisions. Prior to his promotion, he was vice president of Sonneborn Chemical and Refining Corp. He joined Sonneborn in 1943. Before that, he was product sales manager for Union Oil Co. of California.

Cubicciotti

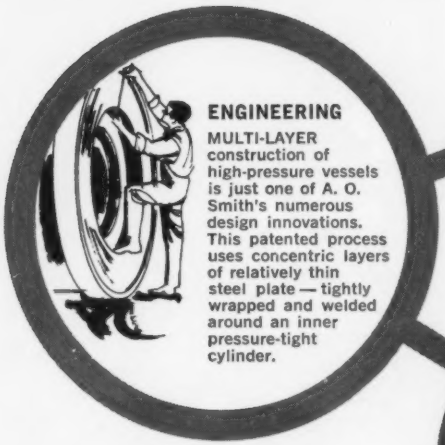
William H. Morris, since 1957 president of Sinclair Oil & Gas Co., and **C. J. Allen,** recently-elected president of Sinclair Refining Co., have been elected to the board of directors of Sinclair Oil Corp. Morris started with the Sinclair organization in 1933 and worked his way up in pipe line transportation through engineering and construction work. In 1936 he was transferred to Sinclair Refining Co. when the pipe lines became operated as a department of that company. Allen was an administrative vice president of Sinclair immediately prior to election to his present post. He joined the Sinclair organization in 1922.

Stephen D. Bechtel, Jr. has been elected president of Bechtel Corp., international engineers and constructors with headquarters in San Francisco. This election marks the advent of third generation leadership into the business founded by his grandfather, W. A. Bechtel. Two presidents, **W. A. Bechtel** and **S. D. Bechtel,** held this office during more than six decades of the firm's activity. Bechtel Corp.'s new president began work for the organization as a student engineer and started full-time employment in 1948 as a field engineer.

Dr. Herman F. Mark, world-famous polymer chemist, has been awarded an honorary degree in natural sciences from the Polytechnic Institute of Munich. It will be the tenth such degree for Dr. Mark, director of the Polymer Research Institute of the Polytechnic Institute of Brooklyn, in his more than 40 years as a chemist. Dr. Mark was co-author for the article, "Watch These Trends in Elastomers," which was published in PETROLEUM REFINER, December 1960 issue.

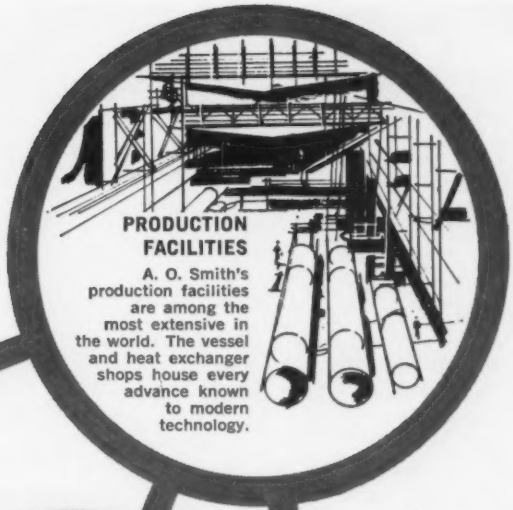
Frank P. Williamson, Houston, has been promoted to assistant superintendent of Continental Oil Co.'s Baltimore petrochemical plant. Formerly technical assistant to the general manager of petro-

INTEGRATED specialization



ENGINEERING

MULTI-LAYER construction of high-pressure vessels is just one of A. O. Smith's numerous design innovations. This patented process uses concentric layers of relatively thin steel plate — tightly wrapped and welded around an inner pressure-tight cylinder.

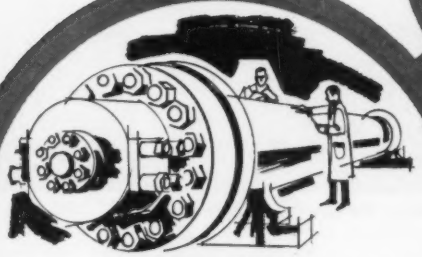


PRODUCTION FACILITIES

A. O. Smith's production facilities are among the most extensive in the world. The vessel and heat exchanger shops house every advance known to modern technology.

WELDING

A. O. Smith is one of the largest production welders in the world. It has pioneered many new concepts for the welding industry.



QUALITY CONTROL

A. O. Smith's high standards for product excellence are a direct result of its ever-expanding test program. Next spring, for example, the world's most powerful metals' inspection x-ray unit will be installed at the Milwaukee plant. The 8-million-volt linear accelerator will "see" through steel more than a foot thick.

RESEARCH

A. O. Smith carries on extensive research in metallurgy, welding, electrical testing, corrosion resistance — to name only a few areas. The company has also become an outstanding contributor in the atomic field.

building block for A. O. Smith leadership in the manufacturing of pressure vessels and heat exchangers

A. O. Smith will build any type, any size of pressure vessel or heat exchanger — *and build it well!* Employing specialists in every phase of its production program, A. O. Smith can guarantee built-in dependability to a wide range of industries from the petroleum and chemicals to the atomic.

A. O. Smith's dedicated staff of research scientists and engineers will help you analyze your process conditions. It will make recommendations as to the design, material and method of fabrication best suited to your particular needs. Write today for specific product information.

Through research ... *a better way*

A.O.Smith
CORPORATION

ATOMIC AND PROCESS EQUIPMENT DIVISION
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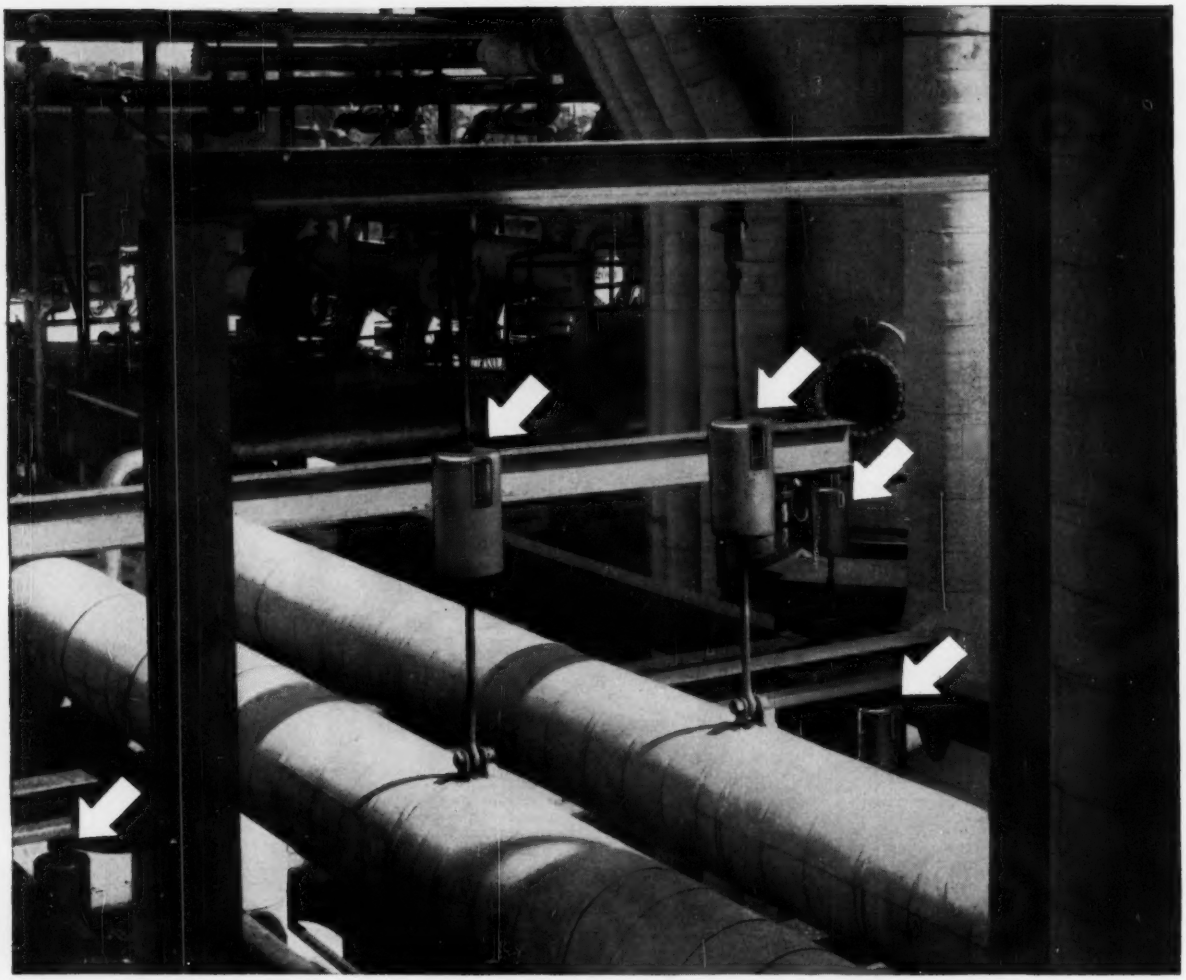
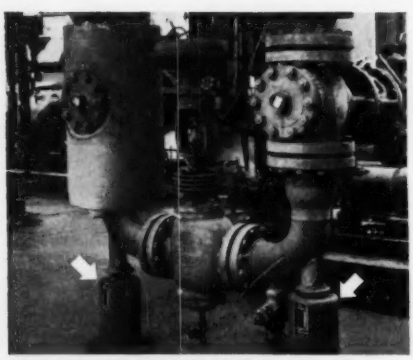


Heater feed line (r.) and return line (l.) at Sinclair Refinery show Grinnell Variable Spring Hangers at work.

Grinnell Hangers support high-temperature pipe lines at Sinclair Refinery



Grinnell Variable Spring Hangers support bottom lines on vacuum still operating at 750°F.

Hot news: Grinnell variable Spring Hangers support pipe lines at Sinclair Refining Company's Marcus Hook, Pa. plant, that operate at temperatures *above 500°F.* Yet these flexible hangers easily accommodate thermal movement in the pipe lines!

Where reactive forces at terminal points must be kept within specified limits, *Grinnell Constant Support Hangers* are recommended. Where pipe lines are subject to vertical movement and restrictive conditions do not require the use of a constant support type, *Grinnell Variable Spring Hangers* are recommended. Where abnormal horizontal movement or vibration in pipe lines must be prevented, *Grinnell Sway Braces* are recommended.

Grinnell maintains a staff of trained technicians... provides highly skilled advice and assistance right from the design stage... offers experienced field engineering service. Call Grinnell Company, 277 West Exchange Street, Providence 1, R. I.

GRINNELL AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Pipe Fittings, Valves, Pipe Hangers, Prefabricated Piping, Unit Heaters and Piping Specialties • Branch Warehouses and Distributors from Coast to Coast

Men . . .

chemical manufacturing at Houston, Williamson will make his new headquarters in Baltimore. He joined Conoco in 1953, and served five years as a research chemical engineer at the company's research laboratories at Ponca City, Okla., before transferring to Houston in 1958.

Frederick C. Wellington has been appointed development manager in the Research & Engineering Division of Monsanto Chemical Co., after serving in the company's Patent Department.

Marnell A. Segura has been named a research associate in the Chemicals Research Division, Esso Research and Engineering Co.

Gerald J. Doyle has been appointed administrative assistant to **Millard E. Stone,** vice president in charge of employe and community relations for Sinclair Oil Corp., and its subsidiaries. Doyle, who joined Sinclair in 1954, is a graduate of Fordham College and Fordham School of Law.

W. A. McElhannon has been promoted to senior supervising engineer, Technical Department, Cracking and Light Ends Division, Baytown, Texas, refinery, Humble Oil & Refining Co.'s Humble Division. He heads the light ends equipment section, which is responsible for the design of new equipment and the maintenance of the various light ends processing units at the refinery. He holds a B.S. degree in civil engineering from Louisiana State University and an M.S. degree from the University of Houston.

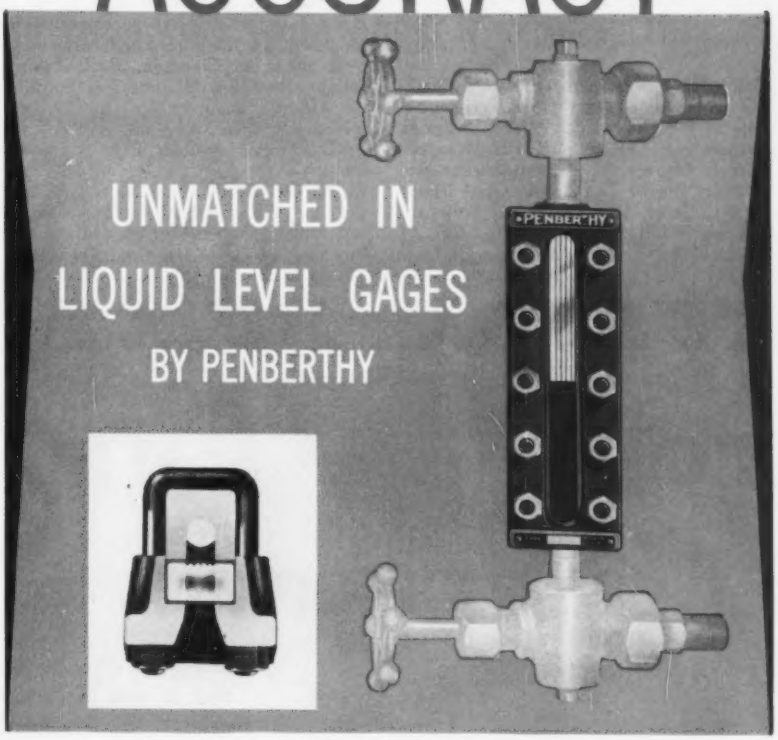
McElhannon

Emil M. Banas, research physicist at the Whiting research laboratories, Standard Oil Co., has been named a trustee of St. Procopius College, Lisle, Ill. He was a member of the class of 1943 at the college.

Robert B. Nicholas has been appointed assistant treasurer, The Atlantic Refining Co. **Robert C. Paarz** has become assistant secretary.

J. Howard Marshall II has been elected president and chief executive officer, Union Texas Natural Gas Corp. He has also been named a director and member of the executive committee of the company. **John T. Oxley** continues as executive vice president. Marshall, who comes to Union Texas Natural Gas from California, was executive vice president, Signal Oil and Gas Co., Los

ACCURACY



Certainly, your *first* requirement of a gage for determining liquid levels in tanks, pressure vessels, boilers, evaporators and other fluid containers is *Accuracy*. The design, materials and craftsmanship incorporated in the construction of Penberthy liquid level gage sets *guarantee* you clearer visibility, unmatched accuracy . . . at temperatures from sub-zero to 750°F. And Penberthy stands behind that statement with a 74-year reputation for unquestioned leadership in gage development and manufacturing.

You may be sure, too, that Penberthy gages are built to simplify service, reduce maintenance, minimize blowout hazard and, above all, to last longer. Want more information? Mail coupon today.

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GENTLEMEN: Want complete details on your liquid level gages. Please send Catalog #36 immediately.

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For more data on advertised products, use Readers' Service Cards, last page.

Men . . .

Angeles, a position he held since August 1959, after joining Signal in 1952. Prior to that he was president and director of Ashland Oil and Refining Co.

Marc Fishzohn has won the Arthur L. Williston Medal from the American Society of Mechanical Engineers. **Ascher H. Shapiro** received the Richards Memorial Award, **George N. Hatsopoulos** was awarded the Pi Tau Sigma Gold Medal Award, **John W. McDaniel,** won the Charles T. Main Award, **Theodore C. Kuchler, Jr.,** received the Undergraduate Student Award, and **Joseph W. Lindsey** was given the Old Guard Prize. The awards were presented at ASME's Winter Annual Meeting in New York City.

Norton H. Walton has been appointed assistant operating superintendent in charge of the SunOlin Chemical Co. urea plant at Claymont, Del. Prior to joining SunOlin, Walton was employed by Atlantic Refining Co. for 27 years. His most recent post was supervisor in the chemicals section.

J. A. Caldwell, Humble Oil & Refining Co., Houston, has been named director, South Central Region, National Association of Corrosion Engineers. **W. C. Koger,** Cities Service Oil Co., Bartlesville, Okla., has been made assistant secretary-treasurer; **Carl M. Thorn,** Southwestern Bell Telephone Co., San Antonio, has been elected secretary-treasurer; and **William F. Levert,** United Gas Pipe Line Co., Shreveport, La., has become chairman of the group.

E. R. Jones has been elected vice president of manufacturing, Derby Refining Co., division of Colorado Oil and Gas Corp. **C. J. Carle** has been named industrial relations manager for the manufacturing and pipe line departments. Jones has been with Derby for 21 years starting as assistant refinery superintendent in 1939. Carle has been with the company for almost 19 years.

Jones

Carle

Dr. Hoke S. Miller has been appointed manager of the Radiochemical and Electrochemical Department at The Lummus Co.'s Engineering Development Center, Newark, N. J.

John R. McClain has been appointed manager, Monsanto Chemical Co.'s Anniston, Ala., plant. McClain was manager of labor relations for the company's Organic Chemicals Division which operates the plant.

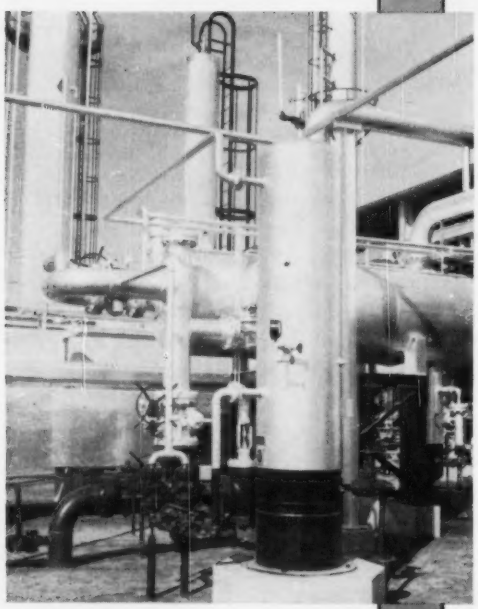
S. H. McManus, a 40-year veteran of Sinclair Oil Corp., has been elected a vice president in the company. McManus began his career with Sinclair in 1920 in the Auditing Department. He was named chief of the auditing staff in 1943. He was elected assistant comptroller in 1950 and comptroller in 1954.

Dr. Gilbert B. Carpenter, director of development for Air Reduction Chemical Co., New York, has joined Mobil Chemical Co. as technical adviser. He will advise Mobil Chemical on expansion of chemical production and research activities in the U.S. and abroad from his headquarters in Rotterdam, Holland.

Arnold F. Kaulakis, acting general manager of engineering, Esso Research & Engineering Co., has been elected a vice president, director and member of the executive committee.

L. J. Maurovich has been named superintendent of the El Chaure refinery and terminal, Sinclair Venezuelan Oil Co., Puerto la Cruz, Venezuela. Mauro-

CUSTOM BUILT TO A T AT TRINITY



Custom refining equipment is built to perfection at Trinity. From planning — to drawing board—to actual fabrication, your requirements and specifications are carried out to the letter. Rigid quality control standards result in your getting the quality you expect for your money.

For a longer life with less maintenance, be sure you get custom equipment built to a "T". The next time you're thinking of new equipment (and want perfection) call on Trinity.

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When in Mexico City, Visit Tanques de Acero Trinity, S.A.

For more data on advertised products, use Readers' Service Cards, last page.

They're ALL Rockwood Ball Valves!

...top performers in refineries from coast to coast!

Throughout the country Rockwood Ball Valves are maintaining unbeatable refinery service — with these proved advantages:

Full Round Flow. No change in shape or volume of stream. No turbulence. Minimum friction loss.

Leakproof Seal. Exclusive spring loaded design holds ball against seat at very low pressure — even at vacuum.

Extra Long Service Life. Chrome-plated ball holds up under toughest abrasion, pitting and scratching.

Quick Opening And Closing with only a quarter turn.

Rockwood Ball Valves deliver refinery liquids at the volume you want — with leakage eliminated and maintenance cut to minimum. Figure 551 shown at right is made in 3″, 4″, 6″, 8″ and 10″ sizes. Available with chrome-plated carbon steel ball, if required — and with Teflon* trim. For superior corrosion resistance specify Fig. 252, with stainless steel body and Teflon trim. Tested and listed by Underwriters' Laboratories, Inc. Write today for full information. Rockwood Sprinkler Company, A Division of the Gamewell Company, A Subsidiary of E. W. Bliss Company, 248 Harlow Street, Worcester 5, Mass. Distributors in all principal industrial areas.

*DUPONT REG. T.M.

Figure 551

BLISS ROCKWOOD

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

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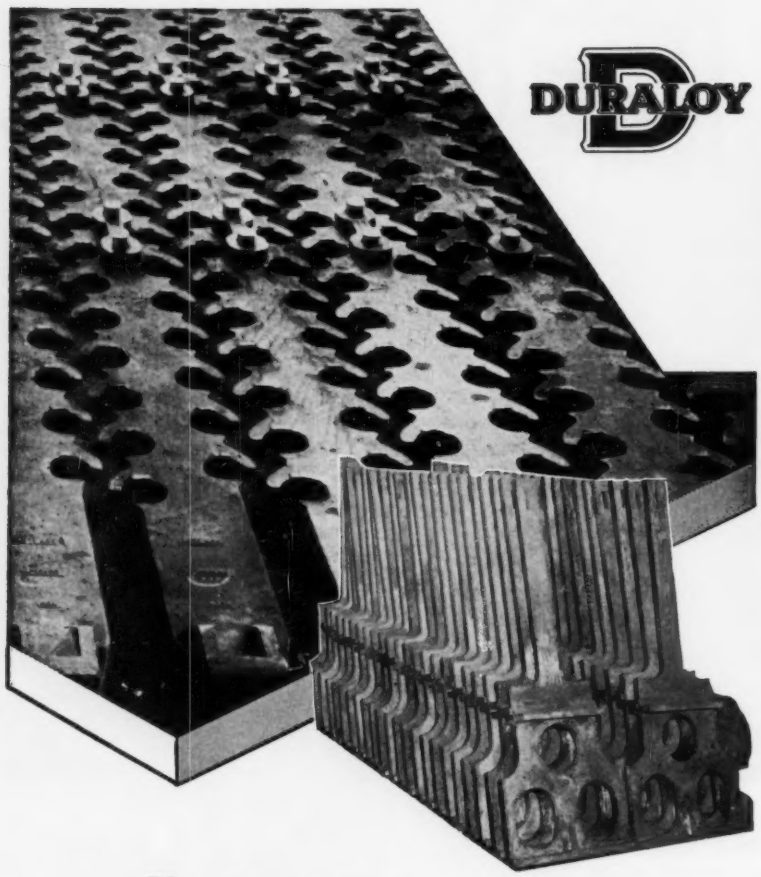
CORROSION RESISTANT
HEAT RESISTANT
Tube Supports



You can't buy Better Tube Supports . . . DURALOY Tube Supports are alloyed to meet individual corrosion and heat requirements. They are alloyed by experienced metallurgists and melted and cast by experienced high-alloy foundrymen, both groups with experience going back some thirty years. Castings are carefully tested in our own laboratories which are completely equipped for metallurgical, chemical and physical testing.

Many refineries have been DURALOY customers for years. Many refineries insist upon DURALOY castings. Whether it's straight production or engineering plus production, we are equipped to do the job. For more information, send for Bulletin No. 3150-G.

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EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.

CHICAGO OFFICE: 332 South Michigan Avenue

DETROIT OFFICE: 23908 Woodward Avenue, Pleasant Ridge, Mich.

Men . . .

vich, who has been assistant refinery superintendent, succeeds **J. J. Connelly,** who has retired after more than 40 years in the Sinclair organization. Maurovich joined Sinclair in 1944, when he started as a customsman. He was promoted to chief clerk and in 1955 became assistant refinery superintendent.

Maynard P. Venema has been elected chairman and chief executive officer, Universal Oil Products Co. Venema succeeds **David W. Harris,** who will continue as a member of the board of directors.

Venema

Harris

Venema has spent more than 25 years with UOP in capacities ranging from chemical engineer to manager of the firm's Patent Department to president and a director. He will continue as president.

Harry A. Jackson, president, American Petrofina; **Don H. Miller,** president, Skelly Oil Co.; **Monroe E. Spaght,** Shell Oil Co.; and **Rickard L. Vockel,** vice president, Waverly Oil Works, have been named new members of the National Petroleum Council for 1961 by Interior Secretary Seaton.

Marling J. Ankeny, director of the Bureau of Mines, U.S. Department of Interior, has been named to head the United States' helium conservation program.

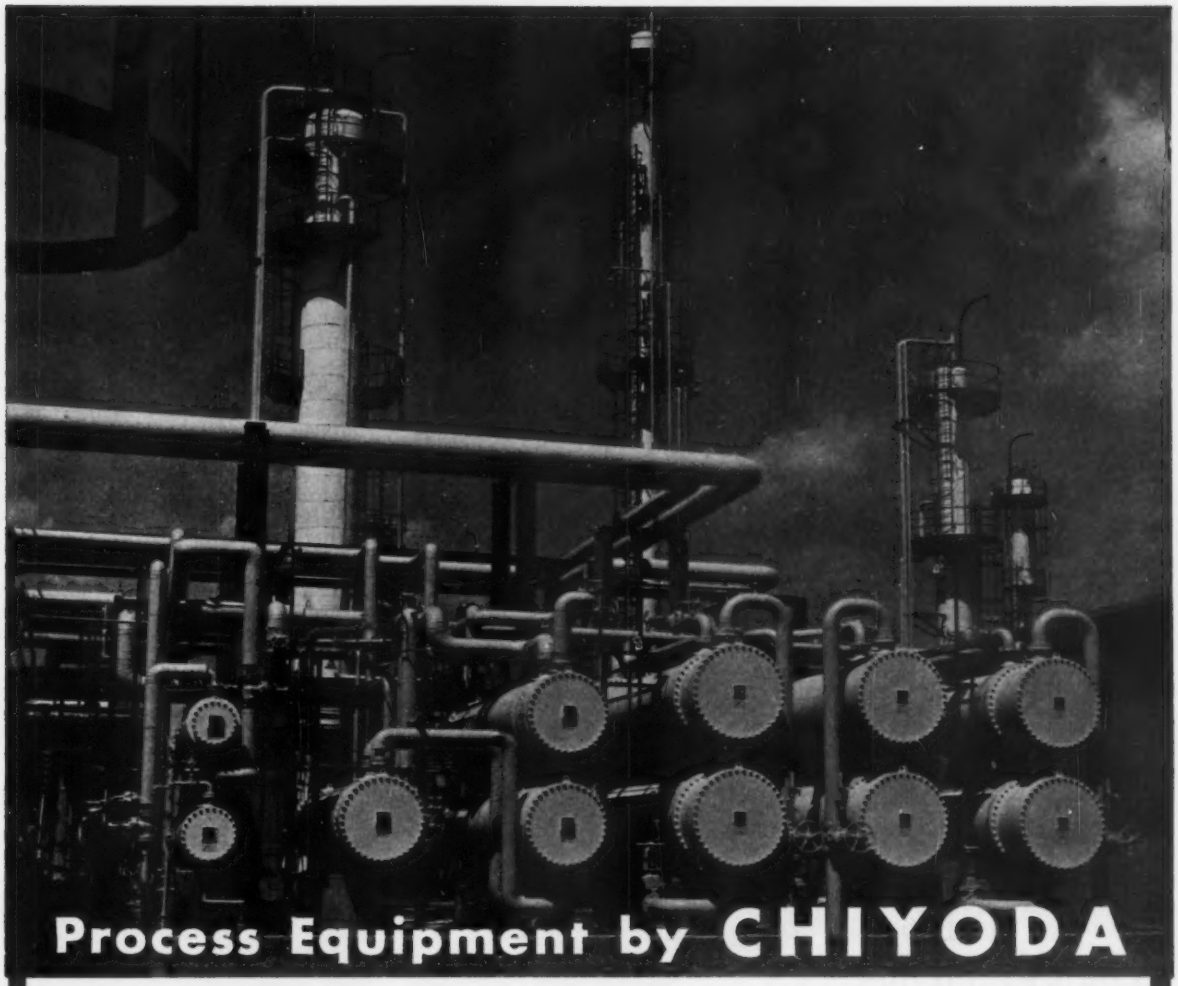
William L. Naylor, senior vice president of Gulf Oil Co., has retired after more than 40 years with the company.

James R. Britt, vice president of Procon, Inc., Universal Oil Products Co.'s construction subsidiary, has been named vice president and general manager of Universal Oxidation Processes.

Paul J. Schauer has been appointed technical superintendent of Monsanto Chemical Co.'s St. Charles, Mo., plant, after serving as a research group leader in the company's Inorganic Chemicals Division at St. Louis.

James D. Wilson has been elected financial vice president of Tidewater Oil Co. Wilson was appointed Tidewater's manager of finance in May 1960, after

For more data on advertised products, use Readers' Service Cards, last page.



Process Equipment by CHIYODA

Heat exchangers, towers, vessels, tanks and other process equipment, large or small, single or by the scores, standard or special, are fabricated at Chiyoda's Kawasaki Factory with the most modern fabricating and testing equipment.
With an integrated organization staffed by specialists in every field plus lower man-hour costs, Chiyoda assures clients of early delivery, low maintenance cost, high operating efficiency and long life.
For your process equipment requirements anywhere in the world, contact CHIYODA.

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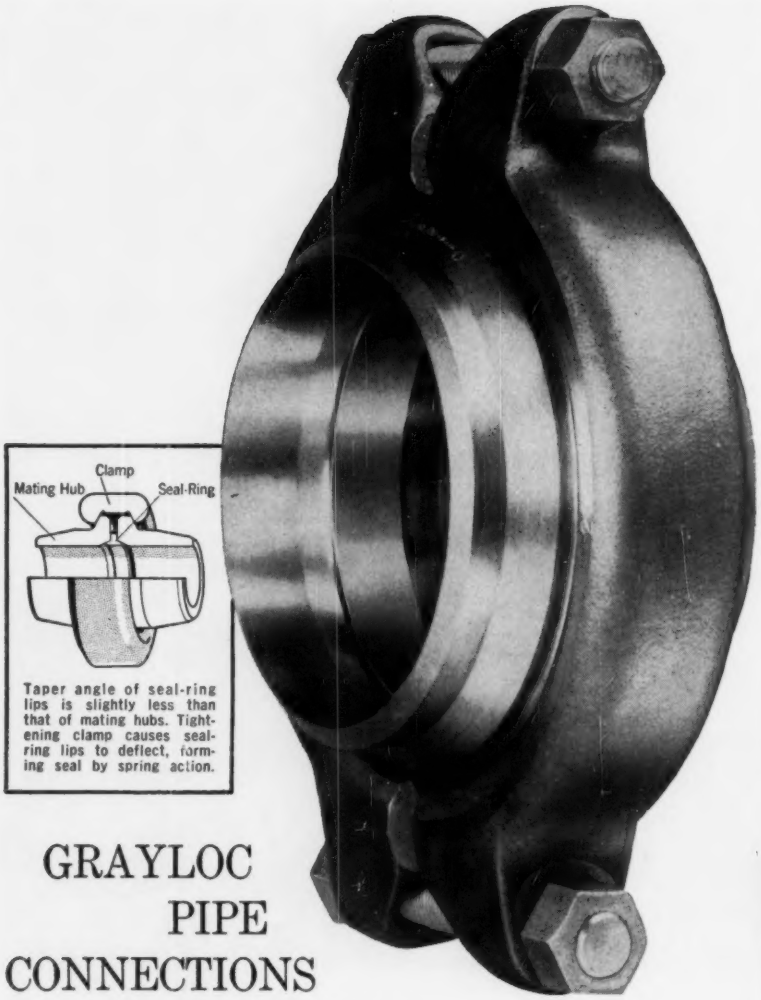

Taper angle of seal-ring lips is slightly less than that of mating hubs. Tightening clamp causes seal-ring lips to deflect, forming seal by spring action.

GRAYLOC PIPE CONNECTIONS HOLD PRESSURE WITHOUT LEAKING

From a full vacuum to extreme internal pressure, GRAYLOC pipe connections will not leak—will not blow out.

It's an all steel assembly with a pressure aided seal that can be quickly and easily disconnected. The seal ring is even re-usable! Yet, for all its sealing power, it's lightweight and small in size.

GRAYLOC pipe connections are manufactured in standard stock sizes from 1" to 30", but special sizes can be manufactured on request. They are also available made of corrosion resistant metals.

Learn how GRAYLOC pipe connections can save you time, space and money. Write for the all new GRAYLOC catalog.

GRAYLOC SALES DIVISION

GRAY Tool Company

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Men . . .

the retirement of **Russell D. Richardson,** former financial vice president. Prior to joining Tidewater in 1959 as controller, a position he will retain, Wilson was financial vice president and a director of Norris-Thermador Corp., Los Anegles.

Ralph Walsh has been elected president of Macmillan Petroleum Corp. and a member of the board of directors. Walsh has been president and sole owner of Armstrong Engineering Co.

W. A. Strauss has been promoted to president and principal operating officer, Northern Natural Gas Co. Strauss has also been elected a member of the firm's board of directors. **A. B. Dilworth,** a senior vice president in the company, has also been named to the board of directors.

Clifford V. Shireman has been appointed manager, economic analysis, California Oil Co. He will be succeeded as superintendent, planning, in the company's Refining Division, by **James J. Motroni.** Shireman joined Caloil at Perth Amboy as a project engineer in 1949. Motroni came to the firm in 1950 as an engineer in process development.

P. A. Ostermayer has been promoted to staff engineer in the Process Technical Division, Baytown, Texas, refinery, Humble Oil & Refining Co.'s Humble Division. He does maintenance engineering at the new polyolefin unit, including trouble-shooting and design modifications. Ostermayer holds a B.S. degree in mechanical engineering from Texas A&M College.

Ostermayer

Dr. Herman E. Ries, Jr., has been appointed a senior research associate, Whiting research laboratories, Standard Oil Company (Indiana). Dr. Ries pioneered in research on interactions that take place at the surfaces of liquids and solids. He joined Standard in 1951.

Arthur S. Alexander has joined the International Chemical Development and Operations Department, Food Machinery and Chemical Corp. He will be located in the department's headquarters, New York City.

Edward W. Nicholson has been named an assistant director in the Products Research Division, Esso Research and Engineering Co. Formerly assistant manager of the firm's refinery liaison unit, Nicholson joined the company in 1956 from the affiliated Esso Research

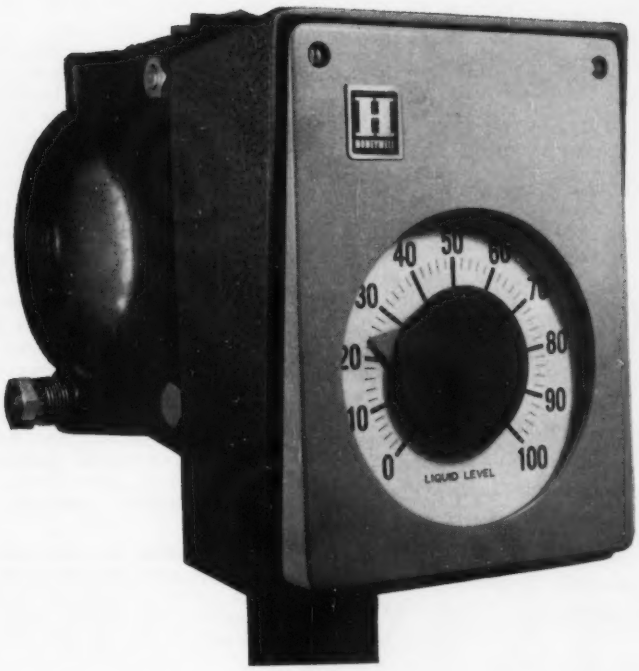
NEW BELLOWS FLOW TRANSMITTER

gives you field indication plus convenience and precision

You get all the economy and convenience of pneumatic transmission and all the efficiency of the bellows meter body plus field indication, when needed, in the new Honeywell Bellows Flow Transmitter. Use it in any application to transmit flow or liquid level measurements in open or closed tanks.

This new meter has automatic ambient temperature compensation and two-way overload protection for 100% of span. Maintenance is greatly simplified by modular construction which lets you remove any major component by loosening two screws. All field adjustments are easily accessible, and a self-locking feature prevents upset after calibration adjustments are made.

You can change ranges in the field simply by removing a single spring assembly and replacing it with an assembly of the desired range . . . adjust damping quickly and accurately, while the instrument is in operation . . . install the meter with either vertical or horizontal piping, so that it vents, drains and purges itself. The meter transmits with calibrated accuracy of ±0.5% of full scale, and indicates within ±1.0% of full scale.



New Bellows Transmitter is available with a concentric scale or as a non-indicator. It has 16 ranges—from 0-10 inches of water to 0-400 inches of water.

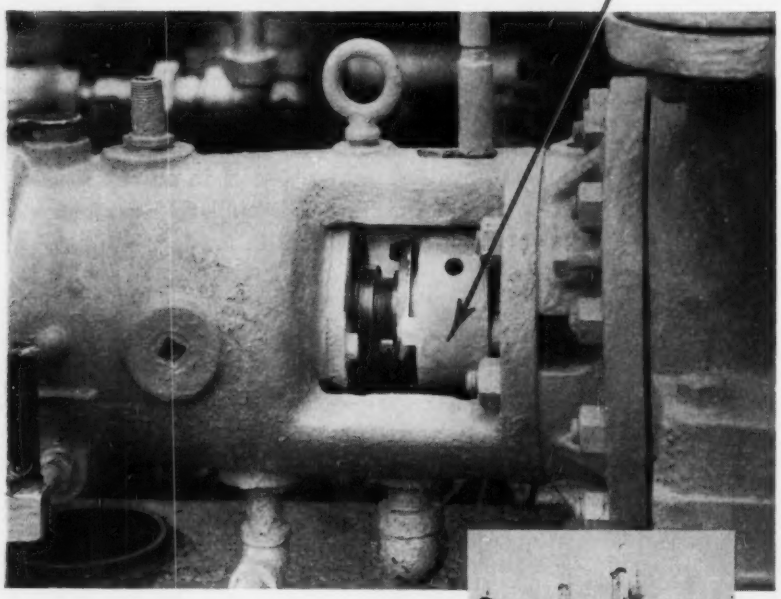
For complete details on the new Bellows Flow Transmitter, call your nearby Honeywell field engineer. Or write MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.—In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

Sealed for 8½ years of almost continuous operation!



Maintenance required —NONE!

Pumping gasoline stabilizer at a temperature of 320°F, and pressure of 300 psig, the Bel Oil Company, Elton, Louisiana, has chalked up a record of 8½ years of almost continuous, day and night service—without any kind of maintenance on this Type U Borg-Warner Mechanical Seal.

When finally taken down after this record run, only the gaskets and seal faces were replaced, and the old faces were re-lapped and returned for use as spares.

This amazing performance is not unusual for Borg-Warner Mechanical Seals. Users in all industries and for all applications report new reliability records.

Write for complete engineering information, no obligation, of course!

Borg-Warner Mechanical Seals

DIVISION OF BORG-WARNER CORPORATION

P.O. Box 2017, Terminal Annex, Los Angeles 54, California

Men . . .

Laboratories in Baton Rouge, La. His Esso career began in 1937 at the Baton Rouge laboratories as a chemical engineer.

James D. Knox has been appointed project manager in the Engineering Department, Monsanto Chemical Co.'s Organic Chemicals Division. He was serving as a superintendent in the Technical Services Department of the division's John F. Queeny plant at St. Louis.

Dr. D. G. Rea has been promoted from research chemist to senior research chemist in the analytical and physical measurements section, Richmond Laboratory, California Research Corp.

Rudolph C. Woerner has been elected vice president, manufacturing, Petro-Tex Chemical Corp., Houston. With Sinclair Refining Co. many years, Woerner joined Petro-Tex in 1955 as director of engineering when that company took over the Sinclair-operated Rubber Reserve Corp. butadiene plant at Houston. He was promoted to plant manager in 1959.

Robert H. Darling has been appointed plant manager of Jefferson Chemical Co.'s Port Neches, Texas, plant. Darling graduated from Alabama Polytechnic Institute with a B.S. degree in Aeronautical engineering. He joined Jefferson Chemical in 1955 as chief engineer of the Port Neches plant. In December 1958 he was made assistant plant manager for engineering, maintenance and construction, a position he held until his recent promotion. Previously, Darling had been with Texas Co., now Texaco, Inc., in various engineering capacities.

Darling

Dr. R. L. LeTourneau has been promoted from group supervisor to supervising research chemist, analytical and physical measurements section, Richmond Laboratory, California Research Corp.

S. G. Miller has been promoted from research engineer to group supervisor, refinery technical service, El Segundo Laboratory, California Research Corp. He replaces **E. H. Lynch** who has been promoted to supervising research engineer in refinery technical service, Richmond Laboratory.

E. C. Greco, senior research chemist for United Gas Corp., Shreveport, La., has been elected president, National Association of Corrosion Engineers, **Rolland McFarland,** secretary and technical director of Hills-McCanna Co., Chicago,

For more data on advertised products, use Readers' Service Cards, last page.

the Tiniest trace of copper contam-ination

AS LITTLE AS 1 PART IN 10,000,000 PARTS OF GASOLINE

ACCELERATES GUMMING IN YOUR PRODUCT

but 3 ounces of Du Pont Metal Deactivator (DMD) is enough to prevent copper-caused gumming in 8000 gallons of gasoline. This is premium protection at an economy price.

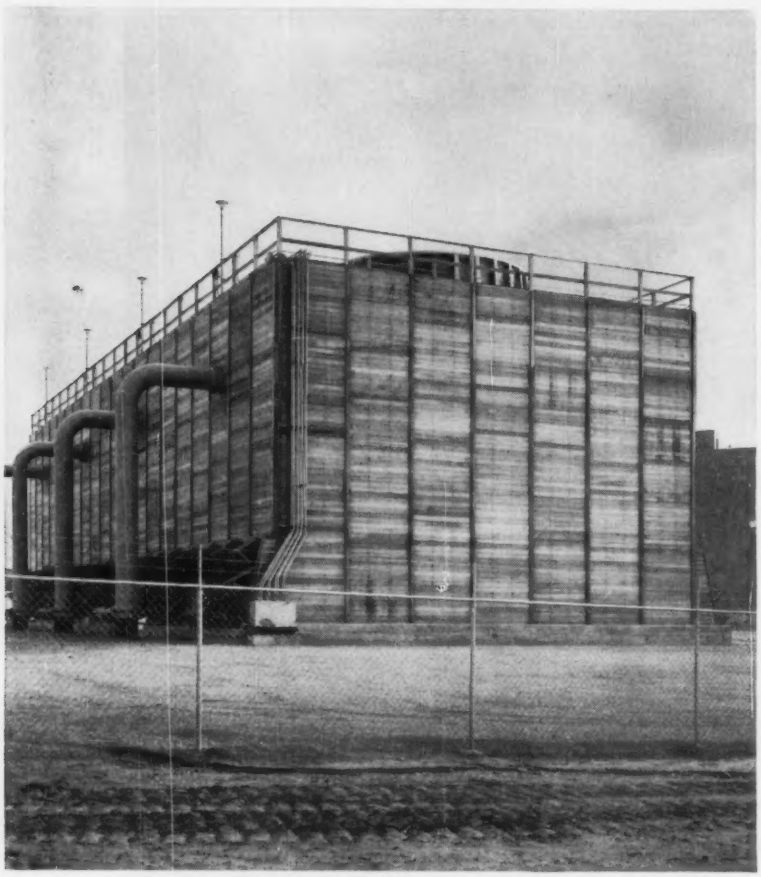
Du Pont pioneered copper deactivation in petroleum products and has been the leader in this field for over 25 years. Constant research and extensive field experience make Du Pont Metal Deactivator your best buy for gasoline, kerosine, jet fuel, fuel oil or diesel fuel. For data, contact your Du Pont Petroleum Chemicals representative, or write: E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

DU PONT LEAD ANTIKNOCK COMPOUNDS
and other PETROLEUM ADDITIVES

DU PONT

Better Things for Better Living
. . . through Chemistry

CORROSION COSTS CAN BE LOWERED



No matter how you figure it—in terms of replacement costs, treatment costs or higher production—Hagan can save you money by keeping cooling and service water systems at top efficiency. Complete treatment recommendations, based on experience with water problems in every kind of industry, are backed up by continuing service after treatment is started. Hagan's methods have achieved these results:

LOWER CHEMICAL COSTS: In most systems, treatment is more effective. This means that smaller amounts of chemicals can be used.

LOWER WATER COSTS: With more effective treatment, it is frequently possible to maintain higher solid concentrations in cooling water. This means less makeup water, and consequent savings in overall water costs.

BETTER RESULTS: In many plants, Hagan methods have reduced corrosion rates to 1 mil per year or less. At the same time, troublesome deposits were eliminated, increasing equipment efficiency, and overall chemical costs were lowered.

A letter or phone call will put Hagan Engineers to work on your particular water problem.

HAGAN
CHEMICALS & CONTROLS, INC.
HAGAN CENTER, PITTSBURGH 30, PA.

HAGAN DIVISIONS: CALGON CO., HALL LABORATORIES, BRUNER CORP

Men . . .

has become vice president; and **C. G. Gribble, Jr.,** district manager for Metal Goods Corp., Houston, has been re-elected treasurer of the organization.

M. H. Clark, superintendent of Continental Oil Co.'s Wichita Falls refinery, has been appointed manager of the company's Panama refinery. Clark joined Conoco in 1930 at the Ponca City and Lake Charles, La., refineries before his promotion in 1948 to assistant refinery superintendent at Lake Charles. He has been refinery superintendent at Wichita Falls since 1958. Conoco's Panamanian refinery, presently under construction, is a project of Refineria Panama, S. A., owned by Conoco and National Bulk Carriers, Inc.

Clark

J. Harold Perrine has been appointed industrial relations director, Sun Oil Co. Perrine, previously assistant director, succeeds **William E. Zimmerman,** who has retired. Succeeding Perrine as assistant director is **John H. Ashenfelter,** presently an assistant to the director.

Dr. Ralph G. Gentile has been appointed a research group leader at the Everett, Mass., laboratories of Monsanto Research Corp., after serving as a research specialist with the Special Projects Department of Monsanto Chemical Co.'s Research & Engineering Division at that location.

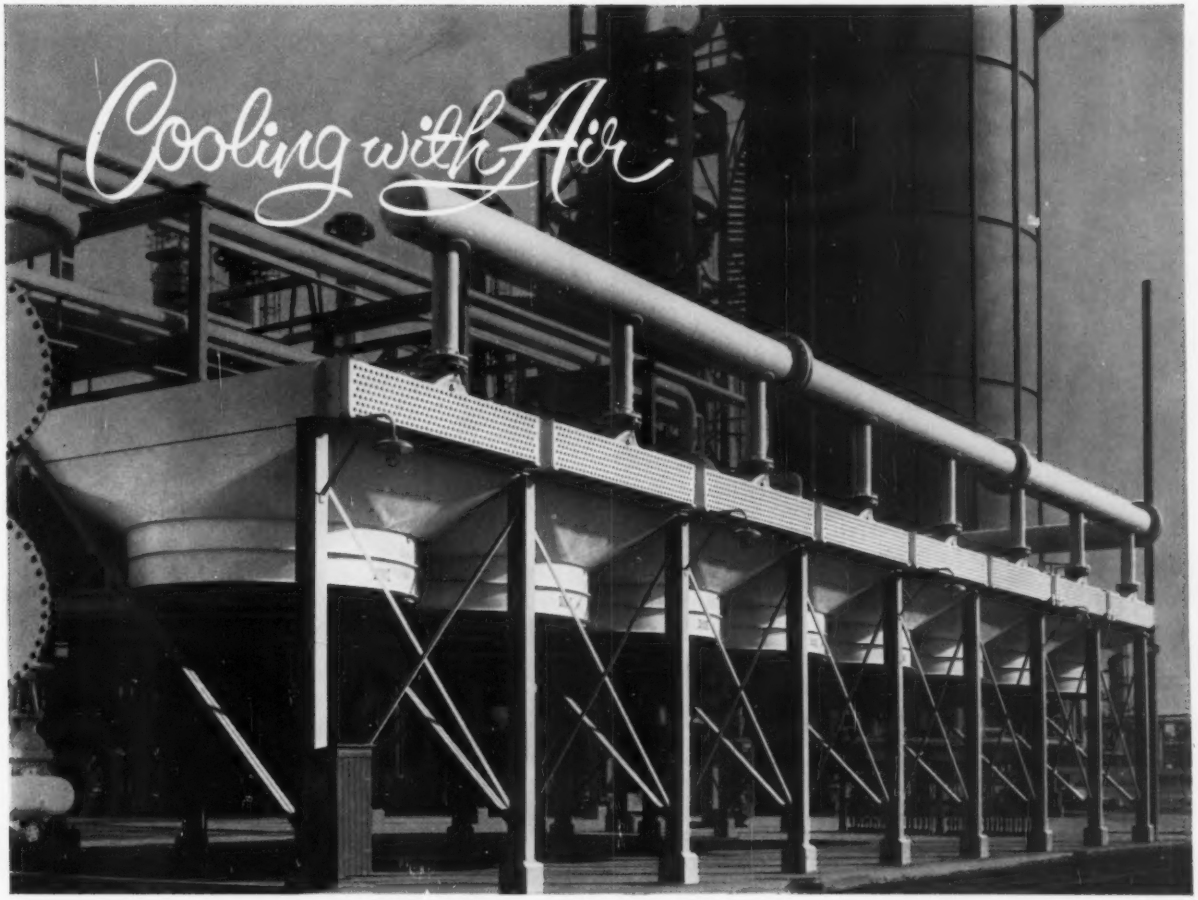
James R. Moore has been appointed area development manager for Canada and for projects without geographical limits after serving in the same capacity for Europe and Canada for Monsanto Chemical Co.'s Overseas Division at St. Louis.

Harold Burrow, executive vice president of Tennessee Gas Transmission Co., has been elected president of the firm. **R. L. McVey,** senior vice president, has been named executive vice president, and **W. C. McGee, Jr.,** president of Tennessee Gas Pipeline Co., has been added to the company's board.

Dr. J. E. Goodrich has been promoted from research chemist to senior research chemist in chemicals exploratory research, Richmond Laboratory, California Research Corp. Goodrich joined Cal Research in 1951 after receiving a Ph.D. in chemistry from the University of California.

Elwood I. Clapp, Jr., technical economist, **Bernard J. Williams,** mechanical engineer, and **Charles J. Paulus,** plant

For more data on advertised products, use Readers' Service Cards, last page.



IN THE BAYWAY REFINERY...

of the Esso Standard Division of Humble Oil and Refining Company.

The above pictured installation of HUDSON Solo-aire units obviated costly addition to the existent and comparatively high-maintenance-cost water system.

Over-all economic comparisons of HUDSON Solo-aire cooling versus water cooling almost invariably result in selection of Solo-aire units for much or all process cooling.

In two complete 40,000 barrel seaside refineries constructed abroad, Solo-aire units are used for ALL process cooling services. NO WATER IS USED FOR PROCESS COOLING.

In the United States in a 40,000 barrel refinery built adjacent to an unlimited water supply, 50% of the total dissipated heat is transferred directly to air through Solo-aire units.

Operating results of thousands of HUDSON Solo-aire units installed in oil, gas and chemical plants throughout the free world have established HUDSON leadership in the field of direct cooling with air.

ONLY HUDSON designs and manufactures ALL THREE categories of cooling equipment . . . for cooling solely with air (Solo-aire); for cooling primarily with air but with minimum water to obtain low effluent process stream temperatures (Combin-aire); and water cooling towers. Take advantage of HUDSON'S objective assistance in selecting the integrated cooling system which best balances capital investment and operating cost for the specific process, climatic, and water conditions.

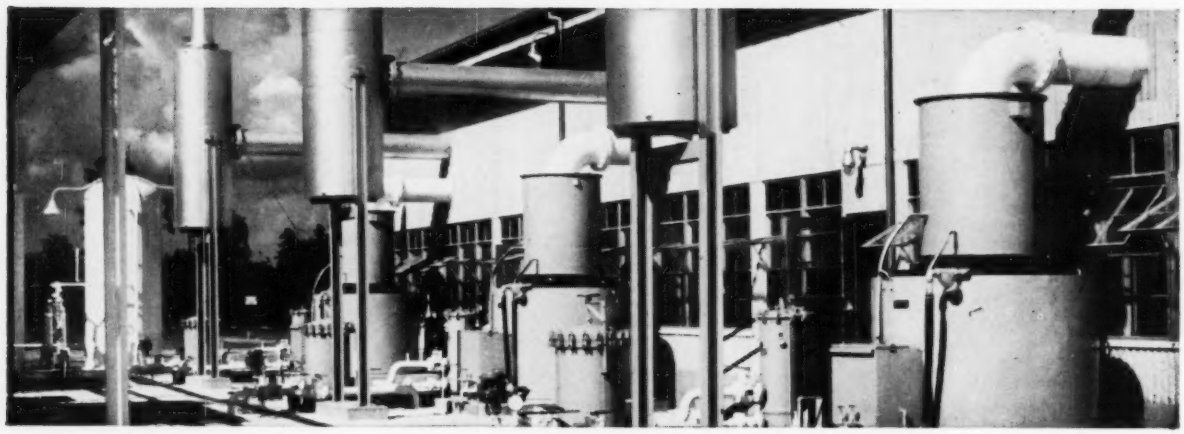
HUDSON

ENGINEERING CORPORATION

BRAEBURN STATION • HOUSTON, TEXAS

OFFICES: 16033 Ventura Blvd. Encino, California • 122 East 42nd St. New York 17, N. Y. • 199 Bay Street Toronto, Ontario, Canada • 17 Stratton St. Piccadilly London W. 1, England • Corrientes 1115 Buenos Aires, Argen. • Rua Mexico 45 Rio de Janeiro, Brazil

AAF cleans gas...



...as well as air on new Texas-Florida pipeline

● On Houston Corporation's new Texas-to-Florida pipeline, both intake air for compressor engines AND gas being pumped are cleaned by AAF!

The pipeline – operated by Houston Texas Gas and Oil Corporation – is bringing natural gas to Florida for the first time. And it's *clean* gas, too, after it passes through AAF horizontal gas cleaners (top photo). These oil-bath cleaners (installed at all compressor stations on the line) remove liquids, contaminants, and foreign matter from the gas before it goes into the compressors for transmission.

Smoother engine performance is assured by AAF Cycoil Kool-Airs (bottom photo). These combination cleaner-coolers – which also operate on the oil-bath principle – condition intake air before it goes into the engine.

American Air Filter can help with *your* air- or gas-cleaning problem – wherever it might be in the petroleum or petro-chemical industry. You can get complete information from your nearest AAF representative, or by writing Mr. Robert Moore, American Air Filter Company, Inc., 452 Central Avenue, Louisville, Kentucky.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

For more data on advertised products, use Readers' Service Cards, last page.

Men . . .

engineer, have joined SunOlin Chemical Co. to work with technical economics, design and maintenance procedures for the company's $20-million ethylene and ethylene oxide plant under construction at Claymont, Del.

Daniel J. Petruzzi has been named community relations manager, Esso Standard Division, Humble Oil & Refining Co., Bayonne, N. J., refinery. Petruzzi, who will direct employe communications and public relations for the refinery, comes to Bayonne from Esso Standard headquarters in New York City, where he was head of the Employe Communication Division. He joined Esso in 1952 after working for several years on Pennsylvania and New York City newspapers and in public relations.

Petruzzi

— Deaths —

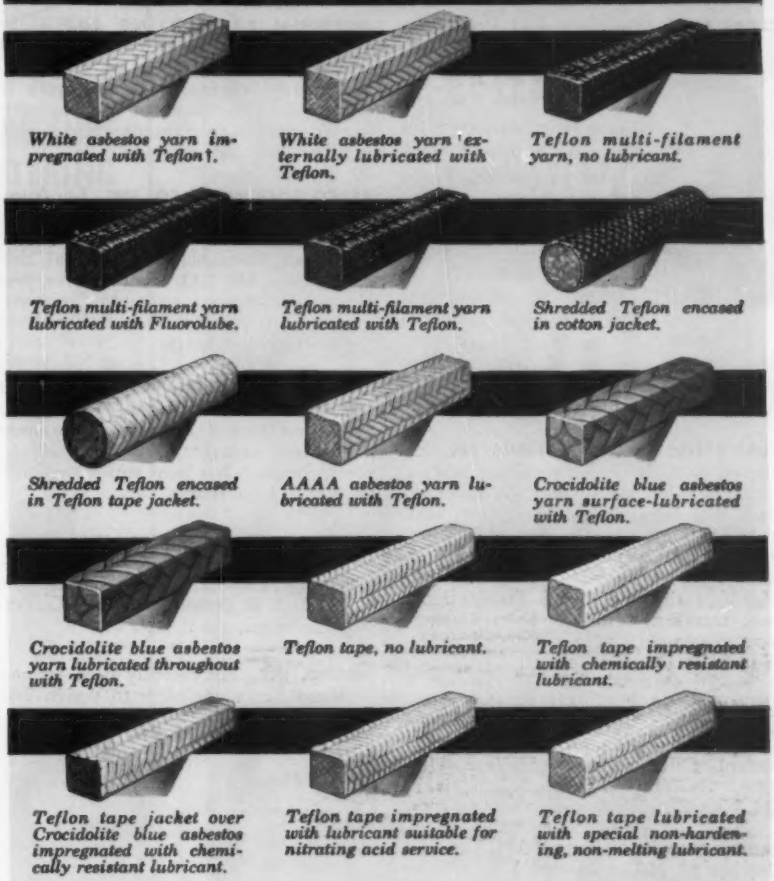
Edward Block, 58, senior vice president and general manager of the Chemicals Division, Olin Mathieson Chemical Corp., died January 4, in Johns Hopkins Hospital, Baltimore, Md. Block joined Olin Mathieson as a vice president in August 1955 when Blockson Chemical Co. joined Olin Mathieson. On that date, he also became vice president and general manager, Blockson Chemical Division.

Col. Thomas Harry Barton, 79, president of Lion Oil Co. from 1929 to 1942, died December 24 at his home in El Dorado, Ark.

Dr. R. P. Anderson, 73, former secretary of the American Petroleum Institute's Division of Refining and a veteran of more than 20 years service to the oil industry, died Nov. 26 in West Chester, Pa., after a brief illness. Dr. Anderson received his Ph.D. at Cornell University in chemistry. He remained at the university as a professor of chemistry for a number of years. He was appointed secretary of the API Refining Division in 1931.

Dr. Charles L. Nickolls, long-time member of the chemical engineering faculty at Oklahoma State University died November 21, after a heart attack. He joined the Oklahoma State University faculty in 1920 and retired in May 1960. He received his B.S. from Dakota Wesleyan, his M.S. from Oklahoma State University and his Ph.D. from the University of Michigan.

15 SPECIFIC PACKINGS FOR ALL CORROSIVE SERVICES


White asbestos yarn impregnated with Teflon†.
White asbestos yarn externally lubricated with Teflon.
Teflon multi-filament yarn, no lubricant.
Teflon multi-filament yarn lubricated with Fluorolube.
Teflon multi-filament yarn lubricated with Teflon.
Shredded Teflon encased in cotton jacket.
Shredded Teflon encased in Teflon tape jacket.
AAAA asbestos yarn lubricated with Teflon.
Crocidolite blue asbestos yarn surface-lubricated with Teflon.
Crocidolite blue asbestos yarn lubricated throughout with Teflon.
Teflon tape, no lubricant.
Teflon tape impregnated with chemically resistant lubricant.
Teflon tape jacket over Crocidolite blue asbestos impregnated with chemically resistant lubricant.
Teflon tape impregnated with lubricant suitable for nitrating acid service.
Teflon tape lubricated with special non-hardening, non-melting lubricant.

John Crane CHEMLON *BRAIDED PACKINGS

Specific service conditions are always best handled with a packing designed for the purpose. This is especially true when it comes to the hard-to-handle liquids in the chemical, petrochemical and refinery industries.

For this reason John Crane has developed 15 individual field-proved types of Chemlon Braided Packings. Within this line there is a type and style that will meet any combination of service conditions and requirements.

1. All known industrial acids, alkalis or solvents.
2. Temperatures from −120°F to +600°F.
3. High or low shaft speeds, also valve stems.
4. Longer packing life due to lower coefficient of friction and non-raveling construction.

Send in your service condition and we will recommend a Chemlon Braided Packing best suited to your application. Request Bulletin P-325.

Crane Packing Co., 6420 Oakton St., Morton Grove, Ill. (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

†*T. M. for DuPont Teflon* **T. M. for the Best in DuPont Teflon*

John Crane

CRANE PACKING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers Notes...

CLARK BROS. CO., division of Dresser Industries, Inc., has named **A. J. Foster** parts salesman and service supervisor for the Dallas-Midland, Texas, district. Foster will headquarter in Albuquerque, N.M. He will supervise spare parts sales to the oil, gas and petrochemical industries in West Texas, New Mexico, and portions of Arizona, Colorado, Wyoming, Idaho and Utah. Foster joined Clark in 1948.

Foster

YUBA CONSOLIDATED INDUSTRIES, INC., has elected **R. A. Beck** vice president and director of sales, Yuba-Tulsa Corp., Tulsa. Beck was formerly vice president, sales Yuba Heat Transfer Division. He is being replaced in this division by **Frederick H. Linley, Jr.,** who was with Allis-Chalmers Manufacturing Co. **E. W. Eschborn** has been transferred to the Yuba Chicago district sales office, in charge of equipment sales to power plants.

UNIVERSAL OIL PRODUCTS CO. has established an office in Los Angeles for marketing its catalytic muffler to aid in smog control. Office of the subsidiary, Universal Oxidation Processes, Inc., is at 811 West Seventh Street.

BADGER MANUFACTURING CO. has named **Georges de Henau** executive sales engineer, Badger N. V., Dutch affiliate of Badger. He will be principally concerned with sales to the petroleum industry in Western Europe.

ELECTRO-MECH CORP., Norwood, N.J., has appointed **A. Scott Hazel** general sales manager. Electro-Mech is a control systems engineering firm and instrument manufacturer. Hazel was formerly with Swanson Engineering & Manufacturing Co. as eastern sales manager.

UNITED STATES STEEL CORP. has elected **Austin J. Paddock** administrative vice president, fabrication and manufacturing. Paddock will be in charge of the American Bridge Division, Consolidated Western Steel Division, Universal Atlas Cement Division and United States Steel Homes Division.

BORG-WARNER CORP. has named **Dr. Robert L. Myers** associate director in charge of chemistry and materials of the Roy C. Ingersoll Research Center. Dr. Myers was formerly with General Electric Co., which he joined in 1947.

WOLVERINE TUBE DIVISION has appointed **W. H. McMath** sales representative in the Birmingham, Ala., district. He will cover sales in Georgia, eastern Tennessee, and Tallahassee, Fla.

INDUSTRIAL FABRICATING CO., Tulsa, Okla., manufacturer of heat transfer equipment, has appointed **Robert A. Frazer** sales engineer. He will work in new product development and engineering in addition to coordinating customer requirements and company sales.

ARCCO INSTRUMENTS CO., INC., Los Angeles, has appointed MacNutt Industries, Ltd., Calgary, Alta., sales representative in British Columbia, Alberta and Saskatchewan. ARCCO manufactures precision instruments for sampling, measuring and analyzing gases and liquids in the petroleum industry.

INTERNATIONAL RADIANT CORP., manufacturers of environmental test equipment, has named **Charles E. Swanson** production manager. For the past 14 years, Swanson has been with Roy Engineering & Iron Works, Inc.

CONSOLIDATED ELECTRODYNAMICS CORP., a subsidiary of Bell & Howell, has elected **Dr. Charles F. Robinson,** director of the Bell & Howell Research Center, vice president.

THERMO, INC., has recently been formed by three Tulsa engineers to design and fabricate process heat transfer equipment for the petroleum, petrochemical and atomic energy industries. Principals in the new firm are **William H. Mason, John J. Griffin** and **Edwin H. Stabert.** Business and engineering offices are located at 801 West 23rd St., Tulsa, Okla. Mason will head the new company's Sales Department. Griffin will handle process design details, and Stabert will serve in an engineering capacity.

Mason

Griffin

Stabert

SOLAR AIRCRAFT CO. has named Tomlinson Steam Specialty Co., Inc., Cleveland, Ohio; DuBois Webb Co., Detroit, and Clarence B. Petty & Co., Needham Heights, Mass., sales representatives for industrial bellows and expansion joints.

SELAS CORP. OF AMERICA has named **Jacob Voogd** sales representative, Fluid Processing Division. Voogd is assigned to the company's Los Angeles sales office, replacing **R. J. Kenard, Jr.,** who has been transferred to Dresher, Pa., as sales manager, Fluid Processing Division. Voogd comes to Selas from E. I. duPont de Nemours & Co., Electrochemicals Department, where he was senior supervisor, vinyl products manufacturing group.

Voogd

JOHN L. DORE' CO., Houston, has named **Clarence H. Hester** sales manager. He was formerly assistant sales manager for the Gulf Coast district. He has been with the company three years. **Richard J. Porter** has been named sales engineer serving the Gulf Coast area from the home office.

INLAND STEEL CO. has transferred **Charles E. Wolfe,** who has been sales assistant in the Houston district sales office, to Dallas. He will represent the company in Northern Texas and Northern Louisiana. **Stuart A. Pennels** has been transferred from the firm's Chicago headquarters to replace Wolfe in Houston.

CONTROL DATA CORP.'s Cedar Engineering Division has appointed **Claude T. Gurley** product manager for data collection and processing systems. Gurley, until recently, was head of the Data Processing Division of U.S. Naval Weapons plant, Washington, D. C.

JONES & LAUGHLIN SUPPLY DIVISION has transferred **L. K. Greer,** salesman at Borger, Texas, to San Antonio, Texas. **F. P. Crahan,** salesman at Beaumont, Texas, has been transferred to Cameron, La.

KAISER REFRACTORIES & CHEMICALS DIVISION has appointed **J. W. Moffett** manager of chemical products sales. Moffett who has been located at Houston, is re-establishing his headquarters at the Eastern Division general sales office, 3 Gateway Center, Pittsburgh, Pa.

ACHESON COLLOIDS CO. has named **Stephen J. Jacobs** sales representative in Cincinnati, Ohio. Jacobs will acquaint and assist industries in the southern, Ohio, eastern Indiana and Kentucky regions with Acheson dispersions and their applications.

CORNING GLASS WORKS has named **Charles L. Goss** product manager, New Products Division. Goss has been plant

REPUBLIC VALVES
FOR EVERY INDUSTRY

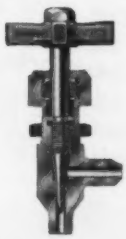
EXTRA HIGH PRESSURE FINE METERING

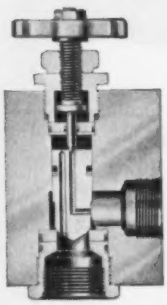
HIGH PRESSURE NEEDLE VALVE

10,000 psi hydraulic service. Forged stainless steel one-piece body. Panel mounting. Good flow characteristics, fine metering, easy to turn. Water, gas, oil and vacuum service, ⅛" to ½" pipe or straight thread tube connections.

MICROMETER ADJUSTMENT NEEDLE VALVE

Best for extra fine metering. Micrometer adjustment, precision taper stem. 5000 psi service –65° to 350°F., oil, water, etc. Brass, aluminum alloy, steel, or stainless steel body. ⅛" and ¼" sizes. Premolded or O-ring packing. Panel mounting.





5000 psi THROTTLE-FLO VALVE

Accurate throttling up to 5000 psi. Finger tip control. Pilot operation of large dynamically balanced piston. Full flow, yet accurate to 1/100 gpm through entire range. Positive seal. Low pressure drop. Aluminum alloy, ½", ¾", 1" internal straight thread connections. Hydraulic seals — others available.

HYDRAULIC BLEEDERS

Primarily used for bleeding air from hydraulic systems, for working pressures to 3000 psi at temperatures from –65° to 180°F.

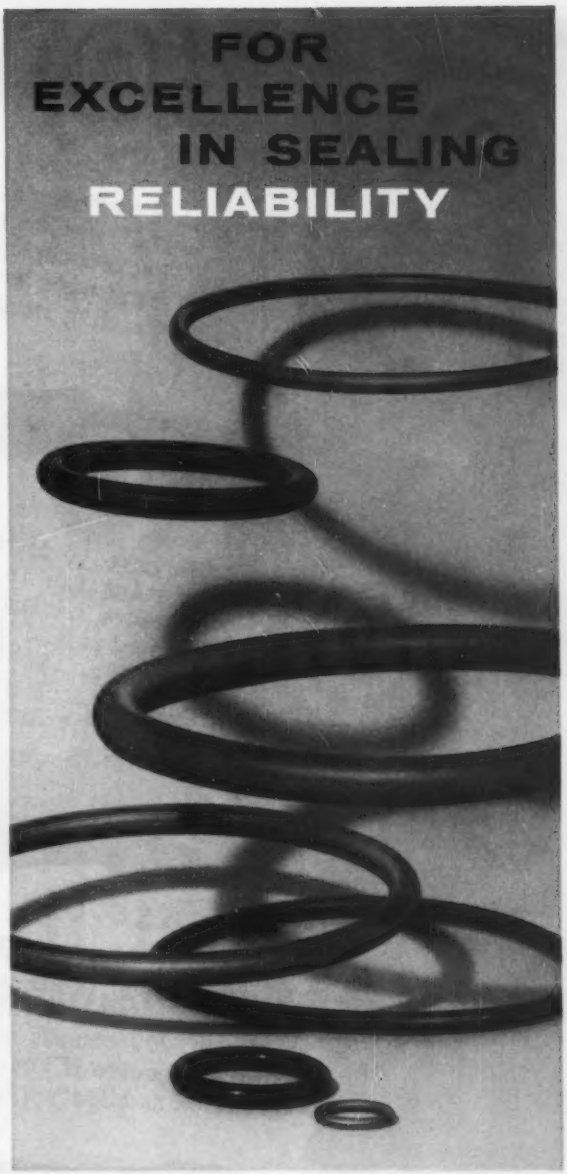
Fluid control valves of many types have been developed and are manufactured by REPUBLIC. A wide line of quality standard valves includes needle, globe, check, plug, selector and relief valves, as well as other units for industrial, chemical, aircraft, missile and ground handling equipment.

Specialists in valving and manifold design to meet your specific application. Write for catalog.

Distributors in principal cities coast to coast

RM REPUBLIC MANUFACTURING CO.

15655 BROOKPARK ROAD, CLEVELAND 35, OHIO



Stillman has an enviable reputation for reliability in the development and production of O-Ring seals for military and industrial applications. The most difficult sealing requirements are met with ease because of Stillman's long years as sealing specialists for military projects where precision and reliability are prerequisites. Stillman O-Rings are produced in a complete range of sizes and compounds for both static and dynamic sealing. These O-Rings have found complete acceptability for the most critical applications. Unusual compounds such as silicone and Viton are standard in Stillman O-Rings. Still more exotic compounds are coming from Stillman laboratories each day, to meet the increasingly complex demands of present-day technology.

For further information, write to:

STILLMAN RUBBER COMPANY

CULVER CITY, CAL./CLEVELAND, O./ENGLEWOOD, N.J.

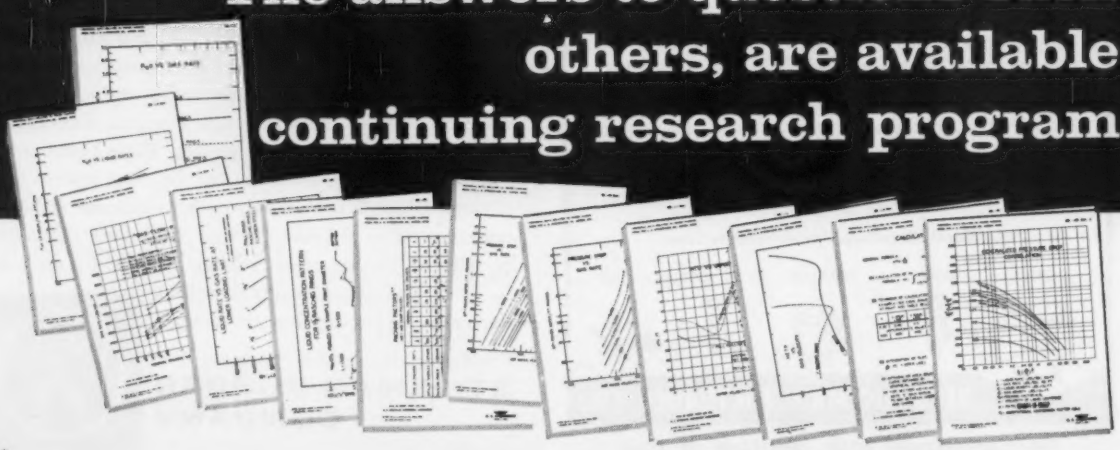
For more data on advertised products, use Readers' Service Cards, last page.

"We are operating at a reflux ratio of 1:1 with a vapor velocity of 4 feet per second. The system is acetone and water. Packed depth is 30' of porcelain raschig rings. How many more transfer units can I get if I switch from 1" raschig rings to Intalox saddles?"

"We have to install an additional scrubber. Our existing fan is good for 7000 cfm with a static pressure rating of 6" of water. The sum of the up-stream and down-stream pressure drops is 3 1/2" of water. We'll be circulating 60 gal. per minute caustic soda solution. Can this fan handle 7000 cfm in a 36" column packed to 25' with 1" rings?"

"I have the problem of reducing the CO_2 content of 20,000 lbs. of air per hour from 1% to less than 1/10 of 1%. Air temperature is 100°F at a pressure of 1 atm. 10% caustic soda is available. What size tower will I require if I pack it with raschig rings? With Intalox saddles?"

The answers to questions such others, are available continuing research program



363-G

"We have a 6' dia. column with 27 bubble cap trays on 18" spacing. It's used to remove CO_2 from ammonia synthesis gas. Solvent is a 15% mono-ethanolamine solution. Can we modify this tower to get a 35% increase in gas treating capacity?"

"We are packing an 8' 6" dia. column with 32 feet of 2" Intalox saddles. The tower will operate at 90 psia. Gas rate 225,000 lbs./per hr. Liquid rate 550,000 lbs./hr. (Sp. gr. of unity). How often should we redistribute? What type of distributor and redistributor should we use? Will we flood at the support plate? What can we do to minimize breaking of the packing if surges occur?"

VISIT BOOTHS 319-320-322
AIChE PETROCHEMICAL
AND REFINING EXPOSITION
NEW ORLEANS, LA.
FEBRUARY 26—MARCH 1

as these, and to countless to chemical engineers through our on packed tower performance

If you are not on our mailing list to receive these releases on packed tower performance, please write, on your letterhead. Previous releases will be sent you immediately. Address Dept. PR-261, The U. S. Stoneware Co., Akron 9, Ohio.

PROCESS EQUIPMENT DIVISION

U. S. STONEWARE

AKRON 9, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

quality and process engineer since April 1959, at Corning's Parkersburg, W. Va., plant. He will be succeeded by **J. Robert Jones,** senior equipment engineer there.

ELION INSTRUMENTS, INC., has named **Herbert Mattelson** controller. Mattelson comes from the industrial electronic products group of RCA in Camden, N. J.

CATALYTIC CONSTRUCTION CO., Philadelphia, has appointed **John A. Hufnagel** manager of Eastern Division sales. Hufnagel will handle sales on the Atlantic Coast and in Eastern Canada. He received his chemical engineering degree at Carnegie Institute of Technology.

TRETOLITE CO., division of Petrolite Corp., has named **Claude H. Collier,** formerly with American Oil Co., refinery chemical engineer at Bound Brook, N.J. **Charles W. Fetrow,** former supervisor for Gulf Oil Corp., Philadelphia refinery, becomes refinery representative at Springfield, Pa.

COOPER-BESSEMER CORP. has appointed **Donald T. Koch** manager of the Detroit branch sales office. Koch will serve Eastern Michigan and Northwestern Ohio in the corporation's east-central sales district. He joined Cooper-Bessemer in 1956 as a sales engineer.

HEWITT-ROBINS, INC., has named **Arley J. Ball** eastern regional sales manager. He will headquarter in New York City and handle sales in the eastern states. Ball was formerly sales manager in the Cleveland district. He has been with Hewitt-Robins since 1947.

DIAMOND ALKALI CO. has named **Dr. Donald M. Black** manager of development and market research. Dr. Black was previously with Monsanto Chemical Co. for 13 years in polymer market research and market development.

WALWORTH CO. has appointed **C. Welles Fendrich, Jr.,** director of marketing research. Fendrich will help develop new markets and coordinate marketing procedures for Walworth's complete bronze, iron, steel, PVC, and lubricated plug valve line.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has promoted **Charles W. Bowden, Jr.,** to industrial sales manager, International Division. **Arthur O. Dietrich** has been named to succeed Bowden as advertising

Bowden

Dietrich

and sales promotion manager of Philadelphia-based divisions. Bowden joined the company's Brown Instruments Division in 1946. Dietrich started with Honeywell in 1948.

WOLVERINE TUBE DIVISION has appointed **Glenn R. Gammill** sales representative to service Louisiana, a section of Eastern Texas, and Southern Arkansas. He will handle Wolverine's complete line of copper, copper alloy, and aluminum tube.

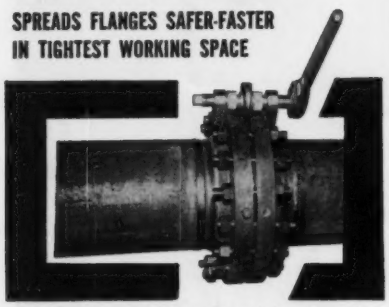
CHICAGO BRIDGE & IRON CO. has appointed **Gordon R. Loveless** manager of its major eastern plant at Greenville, Pa. Loveless was manager of CB&I's Salt Lake City plant since 1957. Succeeding Loveless in Salt Lake City will be **Alfred J. Larson.**

AIR REDUCTION SALES CO. has appointed **L. W. Kunkler** district manager in the Buffalo, N. Y., area. Kunkler succeeds **R. H. Merriman,** who has been transferred to Airco's Philadelphia office.

THOMPSON RAMO WOOLDRIDGE, INC., has named **Dan L. McGurk** director of marketing for TRW Computers Co., the

"SAFETY BOY"

SPREADS FLANGES SAFER-FASTER IN TIGHTEST WORKING SPACE



- Eliminates plant safety hazards and costly down time.
- Spreads all Series pipe flanges. Spreads ring joint flanges.
- Lightweight / Priced right

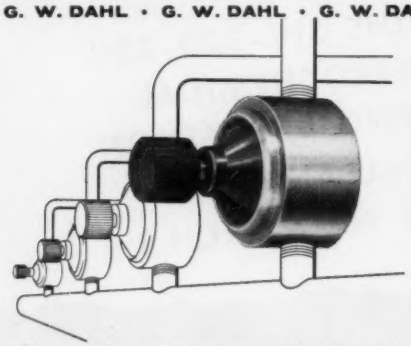
FOR CATALOG SHEET: WRITE TO

Wm. L. Riggs Co.

600 S. 129 E. Ave., Tulsa, Oklahoma

G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL

LOW COST MINIATURE VALVE FOR TIGHT SHUT-OFF!



Dahl FLEXI-PHRAGM packless diaphragm valve ideal for instrument air and other gas and liquid services . . . for isolating and/or testing the pneumatic circuit in process control loops.

Resilient diaphragms (Neoprene, Viton A or Buna) withstand deformation by slurries, trapped impurities (unfiltered service) . . . still provide positive shut-off. Diaphragms resume original configuration when valve is opened and particles washed away . . . even after prolonged closures.

Rated to 500 psig and 180°F. Closing torque only 10 lb.-in. (as rated) in dead end service. Brass bodies with ⅛" or ¼" NPT connections. Panel mounts available.

REQUEST complete data on this low cost, high performance valve. G. W. Dahl Co., Inc., 85 Tupelo St., Bristol, R. I.

G. W. DAHL CO., INC.

SPECIALISTS IN COMPACT VALVES AND CONTROLS

G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL

REFRACTORY HAYDITE

Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.

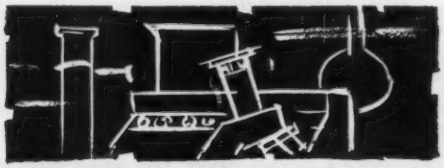
We sell direct to you.

CONSTRUCTION MATERIALS

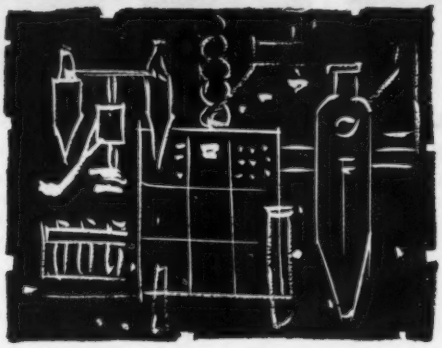
CARTER-WATERS

KANSAS CITY CORP. & MISSOURI

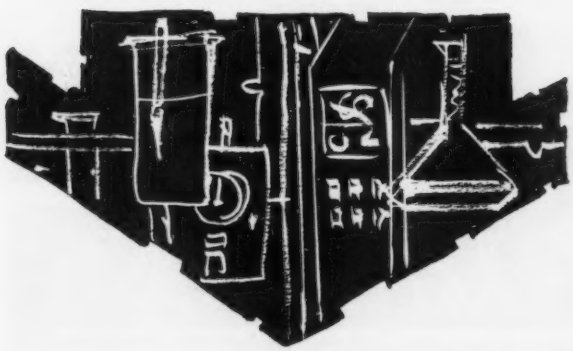
2440 Pennway Phone GRand 1-2570



EVERYTHING FOR THE PETROLEUM LABORATORY



Curtin's conveniently located warehouses throughout the South and Southwest have everything for the petroleum laboratory in stock and ready for immediate delivery. Repair service and technical assistance are always available to Curtin customers. Save time and money by ordering all your laboratory requirements from Curtin, where complete stocks and facilities assure you of the best service.



W. H. CURTIN & CO.

CURTIN

PETROLEUM TESTING EQUIPMENT

HOUSTON • DALLAS • TULSA • NEW ORLEANS
JACKSONVILLE • BIRMINGHAM • CORPUS CHRISTI
CURTIN DE MEXICO, S. A. DE C. V., MEXICO, D. F.

112

As SIMPLE and Dependable as the Pull of a MAGNET!

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

The Simplest, Most Versatile LIQUID LEVEL CONTROL Ever Devised!

Linked to liquid level by infallible magnetic force, Magnetrol is free from the limitations inherent in mechanical or electrical controls. With the actuating magnet rated at 98% of initial strength after 30 years, Magnetrol has *infinite operating life,* with practically no maintenance at all. There are no wearing parts to get out of order.

What's more, Magnetrol's simple operating principle permits easy, economical modification of standard units to meet *any* pressure, temperature or corrosion requirements. That's why there's practically no limit to Magnetrol's use. It's also why "specials" are likely to be standard with us. Magnetrol units control level changes from .0025-in. to 150-ft. —with single or multi-stage switching.

MAGNETROL, Inc.

● SEND COUPON FOR DETAILS

MAGNETROL, Inc., 5312 Belmont Road, Downers Grove, Ill. 5

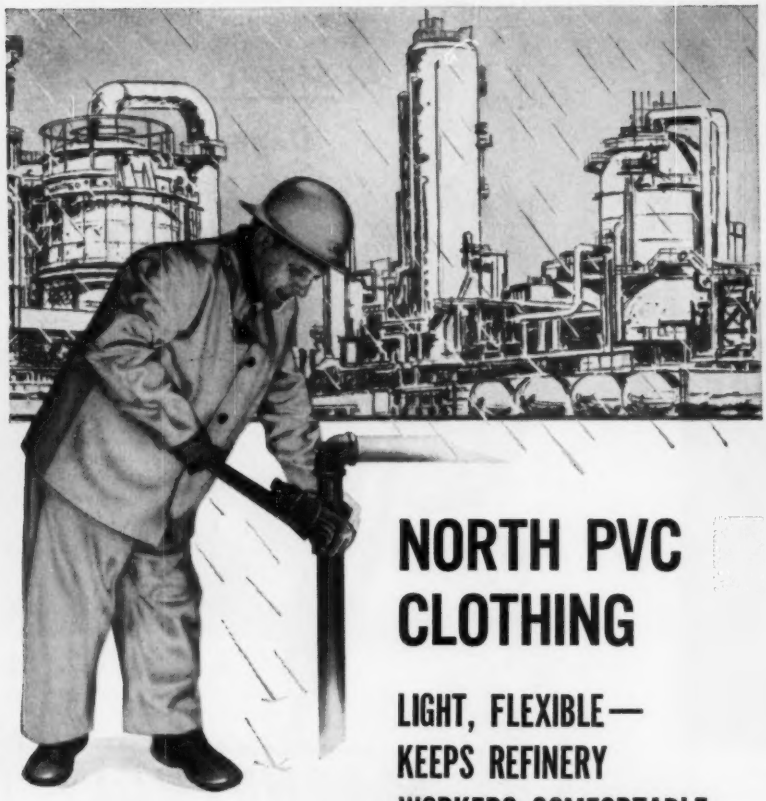
Please send me catalog data and full information on Magnetrol Liquid Level Controls.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____



NORTH PVC CLOTHING

LIGHT, FLEXIBLE— KEEPS REFINERY WORKERS COMFORTABLE

When clouds gather, and rain or snow falls, outdoor refinery workers don North PVC Wet-Weather Clothing by Jomac.

They stay dry because the shielded and electronically welded seams won't pull apart, the welded PVC buttons won't pull off, and the material is absolutely waterproof. They stay safe because North PVC clothing resists most chemicals, oils and greases, is safety yellow for maximum visibility. They stay comfortable because set-in sleeve design and generous cut provide complete freedom of movement.

Insist on North PVC gloves for maximum hand protection. They offer better fit, greater dexterity, more comfort, and superior safety in handling most chemicals, oils and greases.

WRITE TODAY FOR A FOLDER DESCRIBING THESE PROTECTIVE JOMAC PRODUCTS

JOMAC

Jomac Inc., Dept. M
Philadelphia 38, Pa.

In Canada: James North Canada Company Ltd., Simcoe, Ont.
"JOMAC Sells Quality . . . and Quality Sells JOMAC!"

Suppliers . . .

firm's industrial control computer division. McGurk will supervise sales offices in New York, Chicago, Houston, and Los Angles.

GROVE VALVE AND REGULATOR CO. has elected **Harold Wolpman** senior vice president. He will be in charge of plant engineering, plant structures and new plant locations. **Walter L. Connolly** has been

Wolpman

Connolly

named vice president, manufacturing. He was previously director general of Grove France, Paris subsidiary of the firm.

JEFFERSON CHEMICAL CO. has appointed **R. V. Boyce** district sales manager in charge of the West coast sales district. The territory includes Washington, Oregon, California, Arizona, Utah, Nevada and Idaho. Boyce joined Jefferson Chemical in 1954 as a salesman.

CROUSE-HINDS CO. has named **Gunther J. Landers** product development manager. Syracuse, N. Y. Landers was formerly with Construction Equipment Division of Blaw Knox Co., New York Air Brake Co., and Westinghouse Electric Corp.

WOLVERINE TUBE DIVISION, Calumet & Hecla, Inc., has appointed **A. E. Nash** director of operations. Nash replaces **E. C. Walter** who has been named manager of the division's plant in Detroit. Nash joined the firm in 1948 as a methods engineer.

HOOVER BALL AND BEARING CO., Ann Arbor, Mich., has promoted **W. D. Reynolds** to eastern zone manager. Reynolds will maintain offices at Hackensack, N. J., where Hoover operates an assembly plant, warehouse and sales office. Reynolds was previously a regional sales engineer for the company.

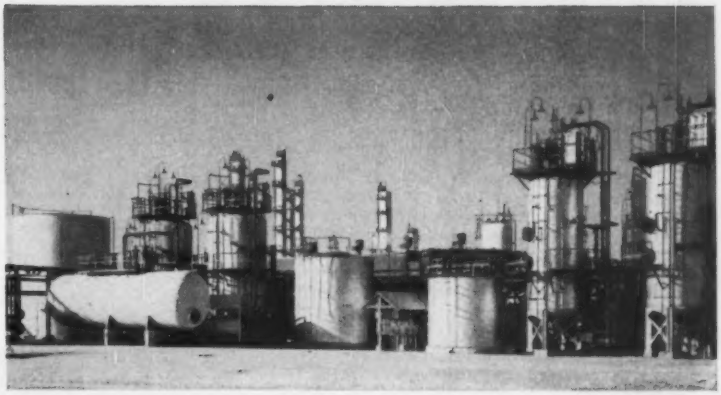
HYDROMATICS, INC., has named **Jack W. Harris** industrial sales manager. Harris comes to Hydromatics from Rockwell Manufacturing Co., where he was assistant product manager, Nordstrom Valve Division.

NELSON MANUFACTURING CO. has named **James E. Van Effen** sales manager of region No. 2. Van Effen was formerly manager of commercial service for the Circuit Protective Device Department, General Electric Co.

For more data on advertised products, use Readers' Service Cards, last page.

PRODUCT IMPROVEMENT WITH **PETRECO**

Compact PETRECO Units help this refiner get better quality... AT LOWER COSTS



Six versatile Petreco treating units handle a wide variety of purification problems for the Richfield Oil Corporation refinery at Watson, California. This compact Petreco installation has a distillate capacity of 60,000 bpd and treats 19 streams, yet it occupies an area equal to only 50 x 100 feet of ground space. By using modern Petreco equipment, Richfield is able to supply increased demands for better gasoline, jet fuels, stove and diesel oils, and at the same time make substantial savings in time and money.

The purification equipment installed by Richfield during a three-year period—1955 to 1958—consists of five Petreco ELECTROFINING* Precipitators and a Bender Catalytic Sweetener. These units were selected to provide a complete flexibility:

A *Stove Oil-Jet Fuel Treater* replaced an older unit in order to meet more stringent specifications for jet fuel.

A *Cycle Oil Treater* was installed to produce a stable product which can be used as a component of locomotive diesel fuel or No. 2 burner oil.

Two *Gasoline Treaters* were installed to remove hydrogen sulfide from straight run gasoline.

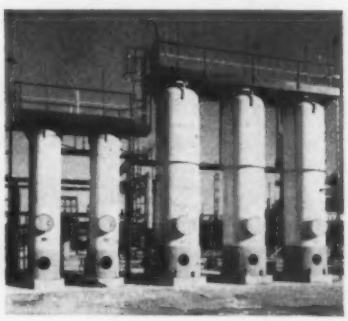
A *Diesel Oil Treater* was installed to give greater efficiency in removing naphthenic acids, and to stabilize the product.

A *Bender Treater* was installed to sweeten distillates from various sour crude stocks.

Bender sweetener vessels consist of two sulphur absorbers and three catalyst towers. Four of the ELECTROFINING units are two-stage treaters; one is single stage.

Richfield has realized these important advantages after installing Petreco treating equipment:

Saving in equipment costs. Continuous treating and "on-stream" blending have largely eliminated the need for intermediate storage vessels. A wide range of products is treated in a much smaller area than other treating equipment requires. *Savings in maintenance costs.* Thorough removal of spent caustic from straight run gasoline keeps exchangers and re-boilers in fractionating equipment operating with a minimum of fouling. *Savings in production costs.* Efficient treating reduces chemical consumption. Spent reagents are effectively removed from distillates. Product loss is low, because electrical separation leaves only a negligible amount of oil in spent reagents. *Savings in labor.* Automatic operation reduces labor requirements and gives more efficiency. *Safe, clean facilities.* All equipment is vapor-tight, for greater safety and cleanliness. There is no air pollution. *Improved product quality.* Treated products contain less sodium, naphthenic acid, mercaptans, sulphur, and color bodies. Storage qualities are greatly improved. Jet fuel passes all specifications without re-treating.



Call on Petreco for sound suggestions for improving your refinery's treating facilities.

DT-60-1

PETROLITE CORPORATION

SUBSIDIARY AND AFFILIATED COMPANIES
CANADA, Edmonton, Alberta • ENGLAND, London
GERMANY, Frankfurt, a. M. • VENEZUELA, Caracas

PETRECO DIVISION
3202 South Wayside Drive (P.O. Box 2546), Houston 1, Texas
1390 East Burnett Street (P.O. Box 7216), Long Beach 7, California

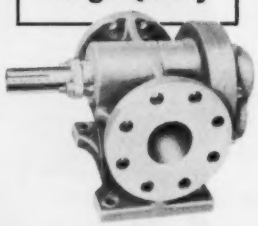
REPRESENTATIVES
ARGENTINA, Buenos Aires • BRAZIL, Rio de Janeiro • COLOMBIA, Bogota
ITALY, Rome • JAPAN, Tokyo • KUWAIT, Kuwait • MEXICO, Mexico, D. F.
NETHERLANDS, The Hague • PERU, Talara • TRINIDAD, Port of Spain

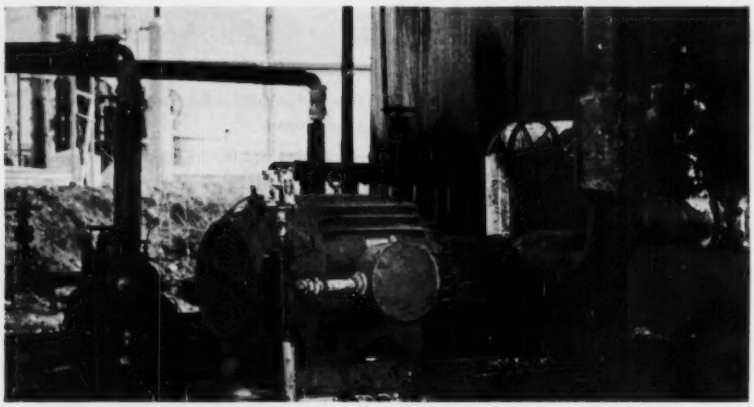
Sier-Bath HYDREX PUMPS

- Small Size
- Big Capacity
- Low Price
- High Quality

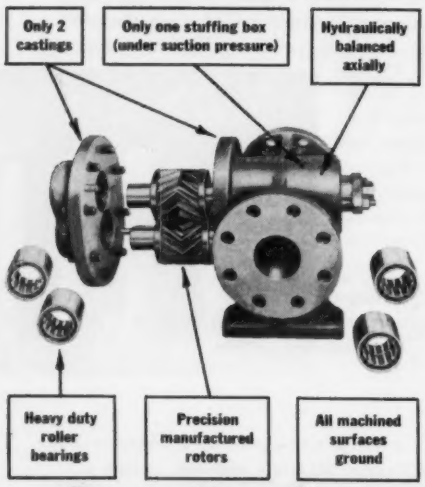
Pumping 320 gpm. of #6 Fuel Oil at THE VICKERS PETROLEUM CO., INC.

• Two compact Sier-Bath Hydrex Pumps were installed in 1957 at Vickers Petroleum Company, Potwin, Kansas. They have been pumping 320 gpm. of #6 Fuel Oil ranging in viscosity from 150 to 1,000 SSU at temperatures of 250° to 150° F. with flooded suction against a discharge of 150 psig. The pumps are driven by 50 h.p. explosion-proof motors at 870 rpm.





Sier-Bath HYDREX PUMP


Only 2 castings
Only one stuffing box (under suction pressure)
Hydraulically balanced axially
Heavy duty roller bearings
Precision manufactured rotors
All machined surfaces ground

The simplest heavy duty gear pump made! Use it in place of pumps costing much more...for handling chemicals, fuel oils, lube oils, hydraulic liquids, etc.

The "Hydrex" needs no costly speed reducer—can be direct-connected up to 1800 RPM. Extreme simplicity allows heavier construction, easier installation and maintenance, less downtime, longer life.

Models available to pump liquids from 32 SSU to 500,000 SSU, at 1 to 350 GPM, up to 500 PSI. See "Yellow Pages" for your local Sier-Bath Pump Representative or write to *Sier-Bath Gear & Pump Co., Inc., 9261 Hudson Blvd., North Bergen, N. J.*

Sier-Bath ROTARY PUMPS

Screw Pumps — Gearex® Pumps — Hydrex® Pumps

Founded 1905 — Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings — Member A. G. M. A.

Suppliers . . .

COOPER-BESSEMER CORP. has appointed **Warren Rhoades** design engineer for special products, Development Division. Rhoades was field sales representative for the corporation's Southwest marketing district with headquarters in Dallas, Texas.

MARBON CHEMICAL DIVISION, Borg-Warner Corp., has elected **William A. Suiter** and **Rhoda M. Stewart** vice presidents. Suiter has been resin sales manager since he joined Marbon in 1958. He will han-

Suiter

Stewart

dle all product sales, including rubber resins, latex and adhesives. Miss Stewart will be director of purchases, Traffic Department and Personnel Department.

KAISER STEEL CORP. has appointed **A. P. Farnsworth** assistant manager, tin plate sales, and **B. J. Wood** assistant manager of plate, structural and bar sales. Both will be located in the company's general sales office in Kaiser Center, Oakland, Calif.

STAUFFER CHEMICAL CO. has named **L. Hunt Myers** manager of the sales development and technical service departments, Industrial Chemicals Division.

GENERAL ELECTRIC CO. has appointed **Dr. Erwin M. Koeritz** manager of manufacturing, Metallurgical Products Department. Since 1956, Dr. Koeritz has been manager of manufacturing engineering in the firm's Silicone Products Department, Waterford, N. Y.

RALPH N. BRODIE CO. has named Holt Pump and Supply Co. Oklahoma City, Okla., meter sales representative. Holt's warehouse and service facilities are at 1529 West Reno St., Oklahoma City.

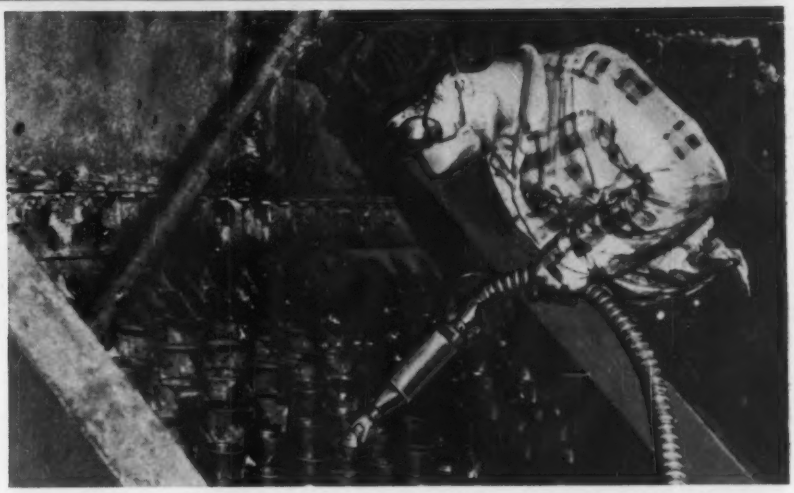
UNITED STATES STEEL CORP. has named **Norman C. Michels** vice president facility planning and appropriations. Michels has been with U.S. Steel's Tennessee Coal and Iron Division as vice president of engineering for the past five years.

ATLAS VALVE CO. has appointed **H. K. Wilson**, St. Petersburg, Fla., sales representative. He will represent Atlas throughout Florida.

MIXING EQUIPMENT CO., INC., has announced the formation of a new company in Poynton, Cheshire, England, to

BETTER TOOLS FOR BETTER WORK

How to clean badly plugged air preheater tubes



Use a powerful Wilson air-driven motor and a heavy carbide-tipped drill bit to clean boiler air preheater tubes in one pass! This is only one of hundreds of tube maintenance jobs where it pays to WILSONIZE TO ECONOMIZE.

Wilson's wide range line also includes powerful tube cleaners, fast, accurate tube expanders as well as Torq-Air-Matic automatic expander drives. Tube cutters, tube pilots, tube knockout tools, right angle worm gear drives—the list of economical Wilson tube maintenance tools is almost endless. Write for your free copy of Wilson Catalog 77-88. It's a mine of information on tube cleaning and tube expanding—in fact, all tube maintenance problems. TW 910

THOMAS C. WILSON, INC. 21-11 44TH AVE., LONG ISLAND CITY 1, NEW YORK
Representatives in principal cities • Cable address: "Tubeclean", New York

THE ECONOMY KING IN ELLIPTICAL MANWAYS

Lenape Wedge Manway

Tap in the wedge . . . it's sealed. Tap out the wedge . . . it's open. That's all there is to the unique Lenape WEDGE MANWAY *. Troublesome, costly bolts and yokes are completely eliminated.

Write today for the full story on the remarkable new Lenape Wedge Manway.

*Patents Pending

LENAPE

Red Man Products

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PENNSYLVANIA

Babbitt *Adjustable* SPROCKET RIM *with Chain Guide* CHANGES THAT DANGER ZONE TO A SAFETY ZONE

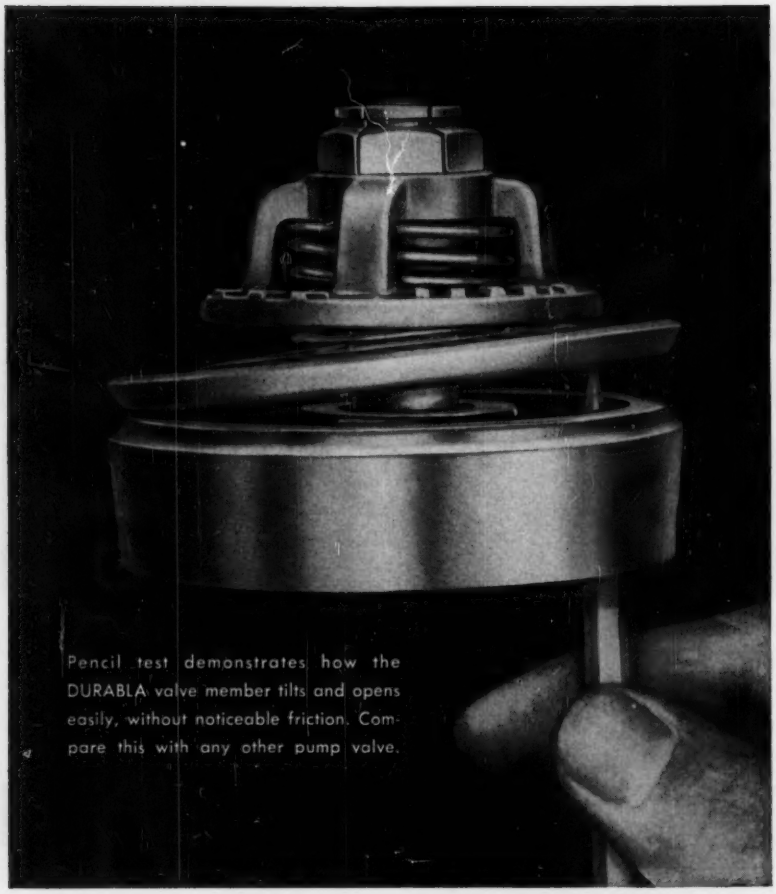
. . . cuts costs when you SIMPLIFY PIPE LAYOUT

When you modernize to make money, go all the way. Cut piping costs to minimum with planned simplification. Give your staff a free hand to effect economics—at the same time, convert Danger Zones to Safety Zones. Equip every overhead valve wheel in your plant with Babbitt Adjustable Sprocket Rims with Chain Guides.

- They simplify pipe layout.
- They fit any size valve wheel.
- They are easy to install and operate.
- They operate any valve from the floor.
- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
- A hot-galvanized rust proof chain is available for all sizes.

Babbitt Adjustable Sprocket Rims with Chain Guide are carried in stock by most mill supply houses. Just phone your mill supply salesman, or contact us direct.

Babbitt STEAM SPECIALTY CO.
6 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.


Pencil test demonstrates how the DURABLA valve member tilts and opens easily, without noticeable friction. Compare this with any other pump valve.

NO. 1 REASON

this is the ideal valve for high-speed pumps

Key to the high efficiency and free action of a DURABLA V-7* Pump Valve Unit is the patented lightweight valve member. Making only "point contact" on the sleeve, it can't bind or hang up. Nor can it warp, thanks to its unique arched design.

This low-lift valve member is designed to open with a tilt, following the flow lines. Valve action is very sharp, thanks to lightness and flexibility. That's why DURABLA is the only valve ideally suited to high-speed operation.

DURABLA valve units operate freely under temperature-pressure extremes, with corrosive fluids and in any position. Available in 17 sizes, they will meet over 300 variations in installation requirements.

Send for booklet PE 20.

DURABLA MANUFACTURING COMPANY
114 Liberty Street, New York 6, N. Y.

DM-35

*Patent applied for

DURABLA®

Manufacturers of DURABLA sheet packing, gaskets and check valves

Suppliers . . .

manufacture and distribute a complete line of industrial mixers in the European market. The new firm will be known as Lightnin Mixers, Ltd.

E. W. BLISS CO. has elected **Clifford C. Childress** a director. **George T. Pfifer,** formerly vice president of finance, has been appointed vice president-assistant to the president. Childress is president of

Childress

Pfifer

John Robertson Co., Brooklyn, a subsidiary of Bliss. Pfifer has been vice president of finance for Bliss for the past four years.

FIRE CONTROL ENGINEERING CO., Fort Worth, Texas, has elected **Harold R. Wesson** vice president. Wesson will be in charge of engineering, research-development and manufacturing for the firm, which makes dry chemical equipment for extinguishing fires involving petroleum. He came to Fire Control in August 1960 as chief engineer. He graduated from the University of Tennessee.

Wesson

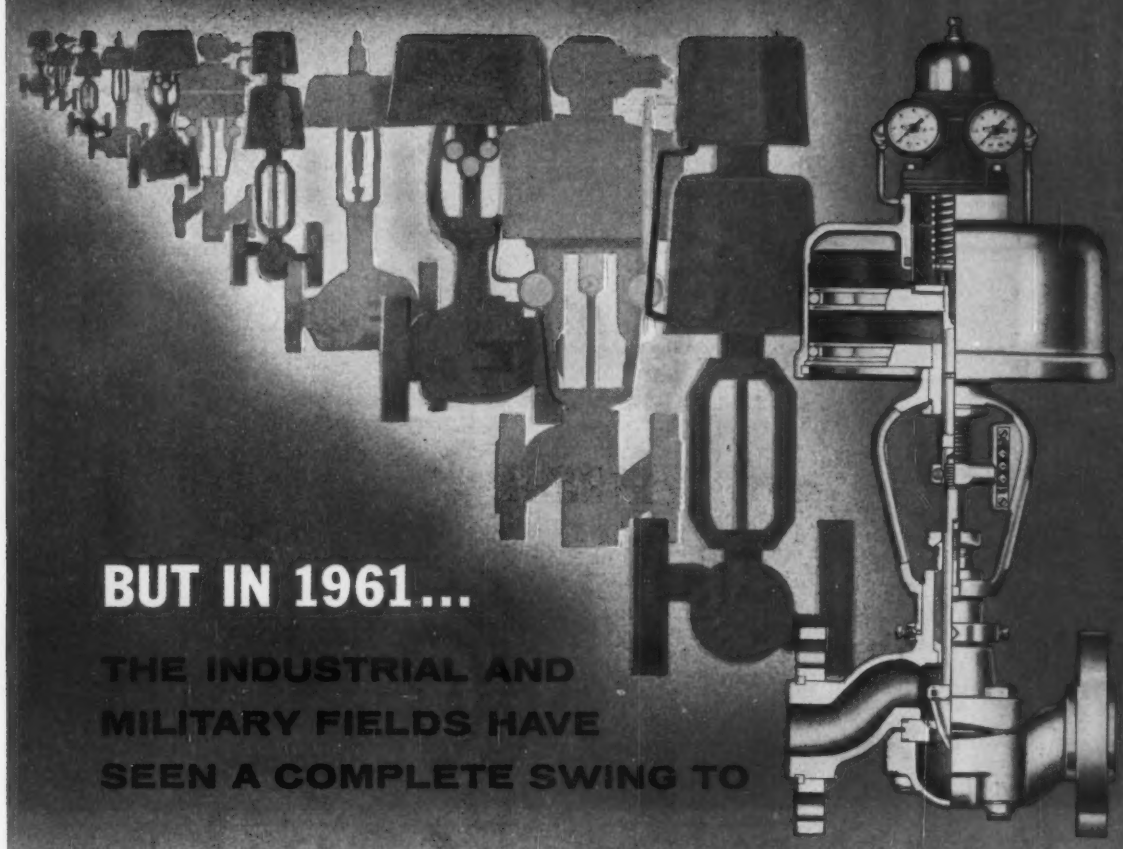
JONES & LAUGHLIN SUPPLY DIVISION has appointed **James A. Bailey** regional salesman, production equipment, Midland, Texas. Bailey will handle the promotion of lease processing and waterflood equipment lines in the West Texas area. He joined the company as a senior clerk in the General Product Sales Department, Tulsa office, in 1959. He attended the University of Tulsa and Tulsa Technical College.

Bailey

FLEXONICS CORP., subsidiary of Calumet & Hecla, Inc., has named **Lloyd G. Fox** vice president and director of marketing. Fox has product sales manager at Flexonics since April 1960.

IN 1948...THEY SAID IT COULDN'T BE DONE

...that split body, single seat construction would never be the accepted design for industrial or military control valves.



BUT IN 1961...

THE INDUSTRIAL AND MILITARY FIELDS HAVE SEEN A COMPLETE SWING TO

CONTROL the ANNIN WAY

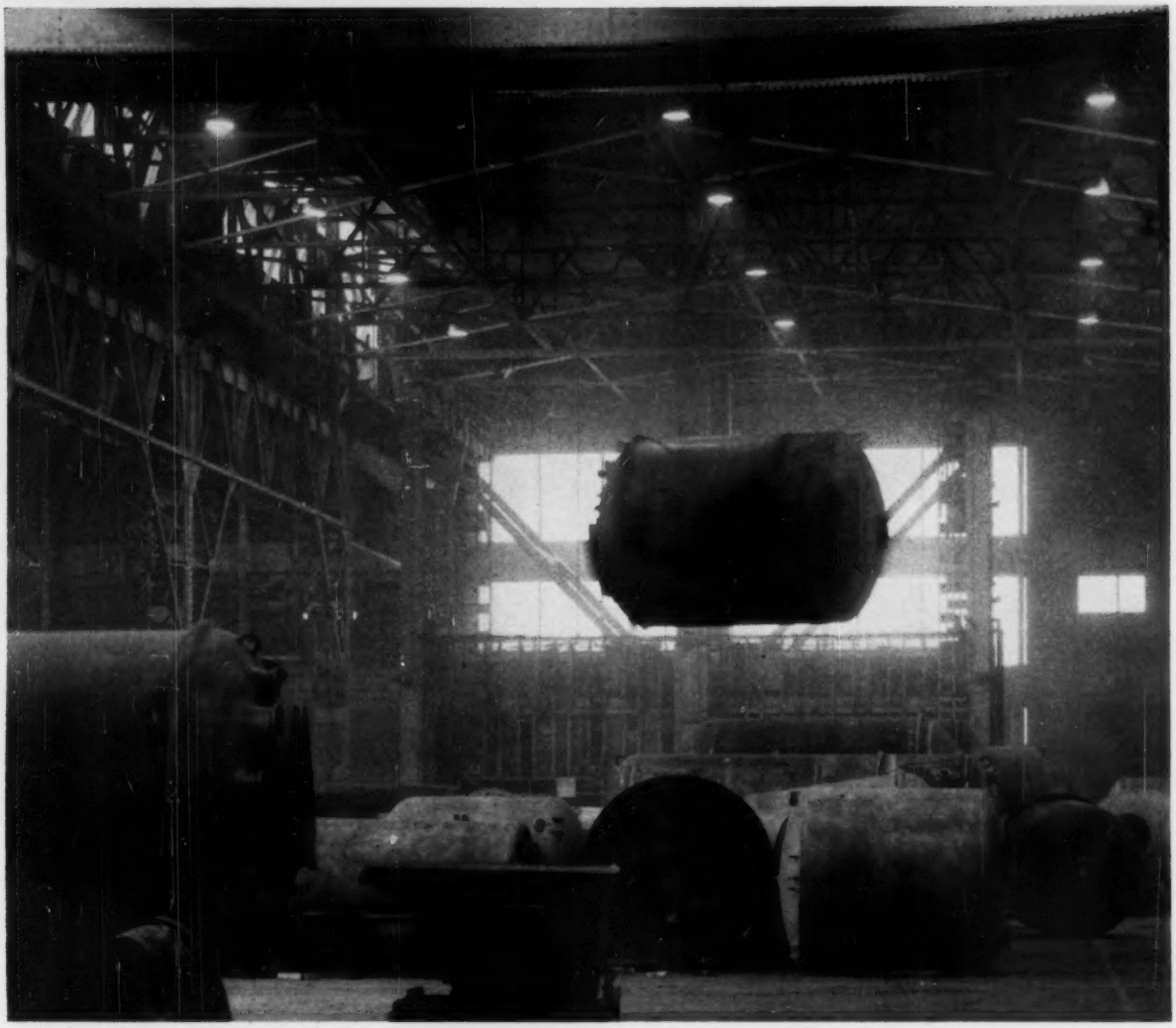
In 1948 split body construction and powerful high speed, precise positioning pneumatic piston actuators were available from only one source—Annin. Today, more than a decade of accumulated experience in this type of valve design makes Annin features and performance records the best in the valve industry. Contrary to published statements by critics thirteen years ago, Annin-type construction is now available from many sources. But when tempted to consider *mere-replicas* of Annin valves, remember this—they might give you a few Annin features, but when you specify Annin Valves you get them all!

Annin VALVES

THE ANNIN COMPANY
1040 South Vail Avenue
Montebello, California

For more data on advertised products, use Readers' Service Cards, last page.

FLUIDICS* AT WORK



New from Pfaudler . . . plastic-coated process equipment to fight corrosion

Equipment of the type shown in the picture above is now available with a corrosion-resistant plastic coating.

The new coating is called Pfaudlon 301.† Developed by our Pfaudler Division, it consists of a water suspension of Penton‡ which is sprayed on and then fired.

Pfaudlon 301 coatings generally can be supplied in 20-40 mil thickness, completely free of "pinholes." It is resistant to the corrosive effects of virtually all acids and alkalies as well as many solvents at temperatures up to 210°F. For certain pre-evaluated services, you may be able to operate at even higher temperatures.

Pfaudlon 301 coats to the desired thickness and forms a hard, nonporous-type surface with as few as two applications. Other plastic coating methods usually require four or more applications.

The coating of complex shapes presents no problem. We've coated such items as agitators, centrifuge baskets and parts, valves, pump impellers and casing, and process tanks—*inside* and *out*. (Note: It is easy to exclude those surfaces that need no coating.)

You also have quite a choice in base metals. We've had good results applying Pfaudlon 301 to mild steel, cast iron, stainless steels, the Hastelloys, brass, bronze and copper.

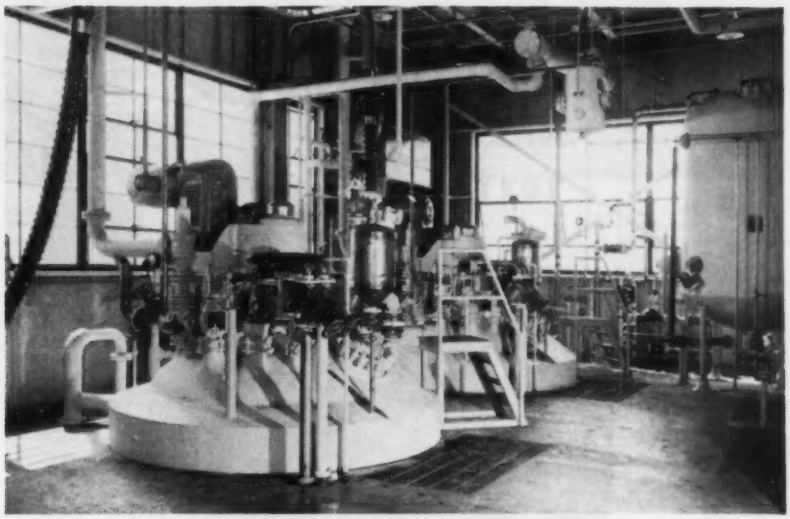
Inside valves, pumps, tanks or what have you, Pfaudlon 301 will permit you to handle *safely* a seemingly endless list of materials. Like? Most acids and alkalies, hydroxides, fluorides and oxides, plating solutions, tanning liquors, crude oil, alcohols, and kerosene, to name a few.

Applied to the *outside* of equipment, Pfaudlon provides exceptional protection against the effects of acid spillage and corrosive atmospheres.

New Pfaudlon 301 will be available in two ways: To custom-coat your existing equipment, or components; we have licensed eight firms around the country. You will find their names listed in the box on the opposite page.

From us, direct, you can get new equipment, fabricated and coated, from either of our two plants. Additional facts covered in a new data sheet, now available.

†Patent applied for
‡Registered trademark for chlorinated polyether manufactured by Hercules Powder Company.



This polymer plant was designed and engineered by Pfaudler as part of its Project Engineering service.

When should you use our Project Engineering service?

Whenever a new plant or expansion requires a temporary addition to your engineering staff, is the concise answer.

Starting with your data, since we do not supply the process or process data, we can provide you or your engineering firm with an integrated design to achieve the required operations and controls.

In essence, our Project Engineering service includes any or all of these functions:

1. Design of system or plant
2. Selection and specification of equipment
3. Layout
4. Procurement and expediting of equipment
5. Contracting for erection, installation and/or construction
6. Start-up assistance and personnel training

We offer specialized experience in solvent recovery — column design — esterification — and polymerization. Our group has designed plants for chlorine dioxide, detergents, resins, and recovery of metal finishing wastes . . . to name the more significant areas.

Where and when we start and how far we carry a project is your decision. A preliminary conference can be arranged at any time.

Please direct all inquiries on Project Engineering services, Pfaudlon 301 coatings, and F-C Glasteel pipe to our Pfaudler Division, Dept. PR-21, Rochester 3, New York.

PFAUDLON 301 LICENSEES

American Durafilm Co., Inc.
2300 Washington Street
Newton Lower Falls 62, Mass.
WOodward 9-9800

Mercer Rubber Corporation
66 Reade Street
New York 7, New York
BArclay 7-0140

Electrochemical Engineering & Mfg. Co.
750 Broad Street
Emmaus, Pennsylvania
WOodring 5-9061
(Rt. 215 + LL)

Tank Lining Corporation
Seminary Avenue
Oakdale, Pennsylvania
BRowning 6-3205

Livingstone Coating Corporation
709 W. Third St., P. O. Box 8282
Charlotte 8, N. C.
EDison 4-1097

Inner-Tank Lining Corporation
4777 Eastern Ave.
Cincinnati 26, Ohio
EAst 1-4777

Industrial Coatings Corporation
3227 S. Shields Ave.
Chicago 16, Illinois
VIctory 2-4828

Hanszen Plastics Co.
835 S. Good-Latimer Expressway
Dallas 10, Texas
RIverside 8-8745

An inside look at F-C Glasteel Pipe**

This is the glass-lined pipe that you can cut to length with any standard dry-abrasive cutoff wheel and then, with a minimum of effort, thread, fire-polish and belt-sand for tight flange connections.

An "inside" look shows another important feature of this high-integrity, lined pipe. The glass lining is not a coating. Rather it is a ⅛-inch *thick* special glass piping permanently fused to the shell of the outer steel pipe.

This means you can expect substantially long service life, even with corrosive and/or abrasive fluids. That glass inside also protects product purity. And it's fire-polished smooth for complete cleaning with a minimum of effort. Outside, of course, the steel provides working strength.

Put F-C Glasteel pipe to work with all acids (except HF) to 350°F. Pipe through most alkalies at moderate temperatures. Handle ultra-pure liquids without concern over contamination from the pipe.

Get it in 1½-, 2- and 3-inch diameters, in any length up to 10 feet, right "off the shelf." For answers to your questions, write for a copy of Bulletin 987.

**Patent applied for

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

For more data on advertised products, use Readers' Service Cards, last page.

FOR SALE

BLACKMER ROTARY PUMPS

All bronze with 25/12.5 H.P. G.E. Electric Motor. Totally enclosed Fan Cooled. For heavy liquid handling; will pump under 50 lbs. pressure with 10′ lift—gasoline, kerosene, thinner, fuel oil, cotton seed oil, lube oil, vegetable oil, mineral oil, etc.

Brand new Blackmer Rotary Pump, #1N401-NV. Rated 400 G.P.M. at 420 RPM, 200 G.P.M. at 210 RPM. Has 4″ Am. Std. Flange inlet and outlet. Equipped with internal relief valve. Pump is mounted vertical on welded steel base. Has horizontal inlet and outlets driven by G.E. frame 405C, 25/12.5 HP 2 speed Vertical Gearmotor, 3 phase 60 cycle, 440 volt (will reconnect for 220 volt).

Includes G.E. 25/12.5 HP 2 speed Controller 3/60/440 24″ x 24″ x 11″ in weatherproof enclosure. Pump and motor 24 x 30 x 70″ high.

U.S. NAVY ACQ. COST . . . Approx. $2500.00—Our Price $850.00 F.O.B. N. Tonawanda, N.Y. Shipping weight approximately 3,000 lbs. 22 available.

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207 Vandervoort St., North Tonawanda, N. Y.

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HI-PRESSURE
turbogenerators, pumps, fans,
Nation's largest inventory, New & Used
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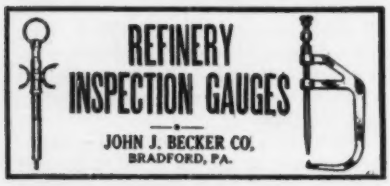

Free Book Catalog

For a free copy of our book catalog write to BOOK DEPARTMENT, GULF PUBLISHING COMPANY, P. O. Box 2608, Houston 1, Texas. Often books reviewed here may be purchased from this source.

Have You Tried a RIDGID® Hex Wrench Yet?

Six Sizes with Maximum Jaw Openings of 1 1/16″, 1 1/2″, 1 3/4″, 2 1/2″, 3 1/2″ and 4 7/8″ across flats.

the Perfect Mate for your RIDGID Pipe Wrench!

Finest of All Adjustable Smooth-Jaw Wrenches

MORE GRIPPING POWER... for all nuts. Puts a wrap-around grip on hexes that just won't slip. Because you're pulling with at least three flat sides at once, you'll never round off shoulders. Works on square nuts, valve packing nuts, unions and gas cocks and flat shapes, too. Smooth jaws won't even mar polished or plated surfaces.

RIDGID No. E-110 Offset Hex Wrench

Big Jaw, Short Handle for Sink and Tub Drain Nuts

Maximum Jaw Opening—2 5/8″ across flats.

RUGGED CONSTRUCTION... built good and solid. Thin but extra-strong jaws slip into tight places. The first time you use a hex wrench you'll know that here's a wrench you'll use for a long, long time. It's every bit as rugged as your familiar RIDGID Pipe Wrench.

RIDGID No. E-11 End Hex Wrench

Offset Jaw for Easy Work in Tight Places

Maximum Jaw Opening—1 1/2″ across flats.

From experience you know it's easier to work with the best of tools.
Order your RIDGID Hex Wrenches from your Supply House today!

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HELP WANTED

INSTRUMENT APPLICATION ENGINEER

Major New England manufacturer expanding activity in gas and oil pipeline and distribution industry has opening for graduate engineer in Application Engineering Department. Several years experience in gas or oil pipe line work desirable. Should have interest in working with field sales engineers and customers on telemetering and other instrument problems. Some traveling. Send resume to:

Box 346-R, PETROLEUM REFINER, Houston, Texas

■ REFINERY ENGINEER—Interesting, diversified duties of process engineer for man with chemical engineering degree. Age 25-35. Refinery experience essential. Position offers many challenging problems. Salary commensurate with experience and ability. Well-planned employee benefits. Send complete resume including salary requirement. Your reply held confidential. Box 348-R.

■ CHEMICAL PROCESS ENGINEER: Midwest refinery wants experienced process engineer to supervise operation of wax units. Send detailed resume including salary requirements, in confidence, to Box 349-R, Petroleum Refiner, Houston, Texas.

HELP WANTED

■ WAX CHEMIST: Midwest refinery wants experienced chemist to carry out research and development programs on wax modification. Send detailed resume including salary requirements, in confidence, to Box 349-R, Petroleum Refiner, Houston, Texas.

PROCESS ENGINEER

Position available for graduate Chemical Engineer with minimum 2 years experience processing work on light hydrocarbon or petrochemical plants.

Call or Write

T. D. TABBERT

Chief Process Engineer

The Fish Engineering Corp.

796 M & M Building

Houston, Texas

HELP WANTED

■ CHIEF CHEMIST: Independent refiner seeking a chemist or chemical engineer with experience in lubricating oils. Position entails direction of new research facility as well as supervision of control laboratory. Applicants must be experienced to be considered—Southern inland location. Write Box 347-R, PETROLEUM REFINER, Houston, Texas.

■ REFINERY SUPERINTENDENT—Independent integrated Oil Company needs Superintendent for expanding small established refinery located in small town in the Middle West. Reply to Box 345-R. Petroleum Refiner, Houston, Texas.

POSITIONS OPEN

PROCESS ENGINEER

Chemical Engineering degree required with a minimum of three years refinery experience including the operations of Fluid Catalytic Cracking Units and H.F. Alkylation Units.

MECHANICAL ENGINEER

A Mechanical Engineering degree required with a minimum of two years refinery maintenance experience in at least a foreman capacity.

FIRE MARSHAL and SAFETY INSPECTOR

Applicants should have experience as Fire Marshal and/or plant safety inspector in a refinery, chemical plant or a related industry.

These positions have been created as a result of a modernization program in a 15,000 bpd refinery. Employee benefits in effect are retirement plan, thrift plan, vacation, hospitalization and group insurance.

If interested in any of these positions send complete resume including references and salary range desired. All replies will be acknowledged and remain confidential. Mail to:

PERSONNEL DIRECTOR
MURPHY CORPORATION
Superior Refinery
Superior, Wisconsin

HELP WANTED

TO THE PROVEN PROJECT MANAGER WHO IS SATISFIED WITH HIS POSITION . . . BUT WHO IS CAPABLE OF GREATER MANAGERIAL RESPONSIBILITY

One of the Leading International Engineering Organizations, Located in the New York Metropolitan Area, Now Offers Unexcelled Growth Opportunities With Its Staff of High Level Engineers.

DO YOU HAVE . . .

. . . A Chemical, Mechanical or Civil Engineering Degree?

. . . A minimum of 10 years experience (preferably engineering architectural contracting) in the chemical, petro-chemical or petroleum field?

. . . The initiative to meet the challenge of complex assignments?

. . . The ability to successfully motivate engineering specialists?

IF SO . . .

You may possess the right qualifications for this select opportunity. You will associate with a high level staff group engaged on a wide variety of projects and enjoy outstanding working conditions as well as liberal benefit plans. Your salary will be commensurate with your experience.

TO REPLY . . .

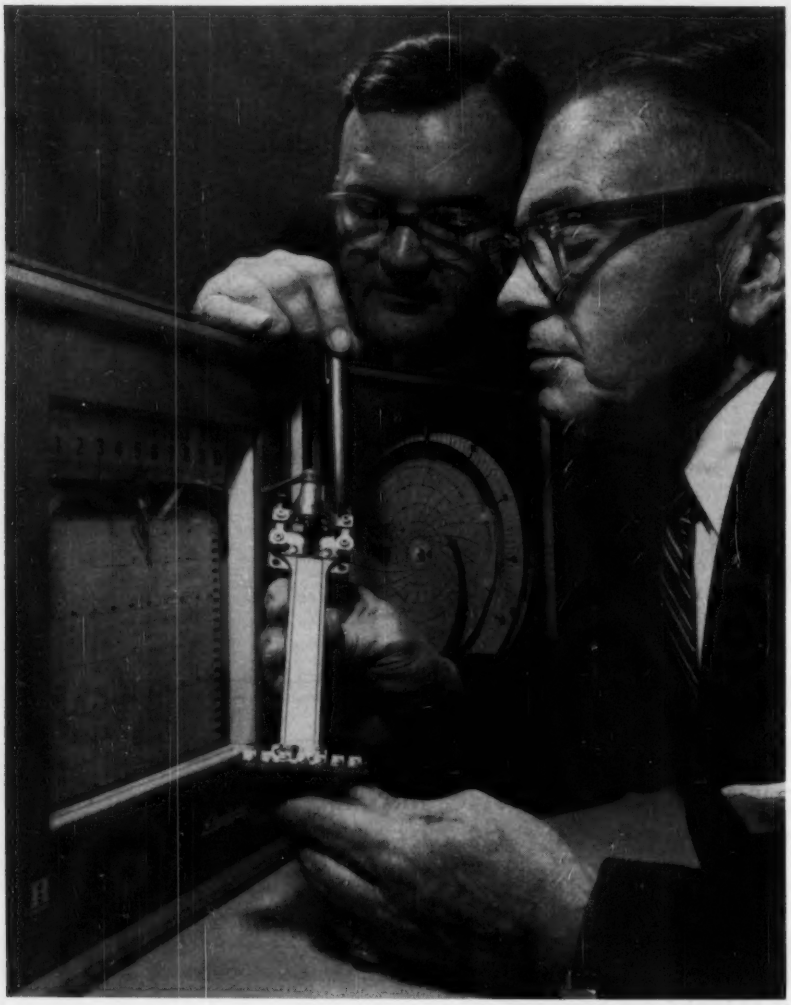
Send letter enclosing a resume or description of your professional experience. All replies will be held in complete confidence.

Box PR 1784, 125 W 41 St, NY 36

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment & Literature...

as selected by Frank L. Evans, Jr., Maintenance & Design Editor



This device may open a new era in precision measurement and recording.

Potentiometer Eliminates Conventional Slidewire

A new industrial process potentiometer described as revolutionary in concept was made possible by a scientific breakthrough in the state of the art.

The new device, called the ElectroniK 17 and incorporating an extremely accurate, trouble-free electromechanical strain gage as the rebalancing element, is expected to open up a new era in precision measurement and recording in industry.

In eliminating the conventional slidewire, long an objective of instrumentation engineers, infinite resolution is achieved for the first time in a potentiometer. No longer is the number of points at which a potentiometer can come to balance limited to the turns (convolutions) on a slidewire.

As the "heart" of the ElectroniK 17, the Stranducer, a radically different rebalancing mechanism, varies the output potential of the measuring circuit to balance the input signal from the process variable.

Features of the system are:

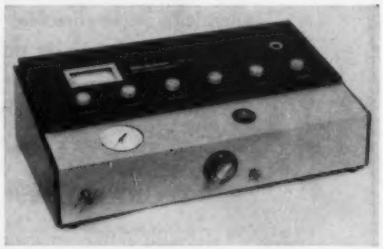
- Isolation of all critical components within an electrical shield, thus rejecting stray signals that cause recording errors and effect the dynamics of the instrument.
- One true reference junction compensation for all types of thermocouple actuation.
- Transistorized plug-in control units up to a maximum of eight set points for auxiliary or zone control. Any combination of these can be supplied as original equipment or modified as required by the user in his own plant. Compact transistor units control the contact action of single-pole double-throw relays and a single plug-in power supply furnishes input signals to all control system components. Minneapolis-Honeywell Regulator Co.

Circle E1 green card, last page

Gas Chromatograph 10 to 20 Times More Sensitive

A new gas chromatograph incorporates the stability, sensitivity, fast response, and high resolution required for today's wide and growing range of chromatographic analyses.

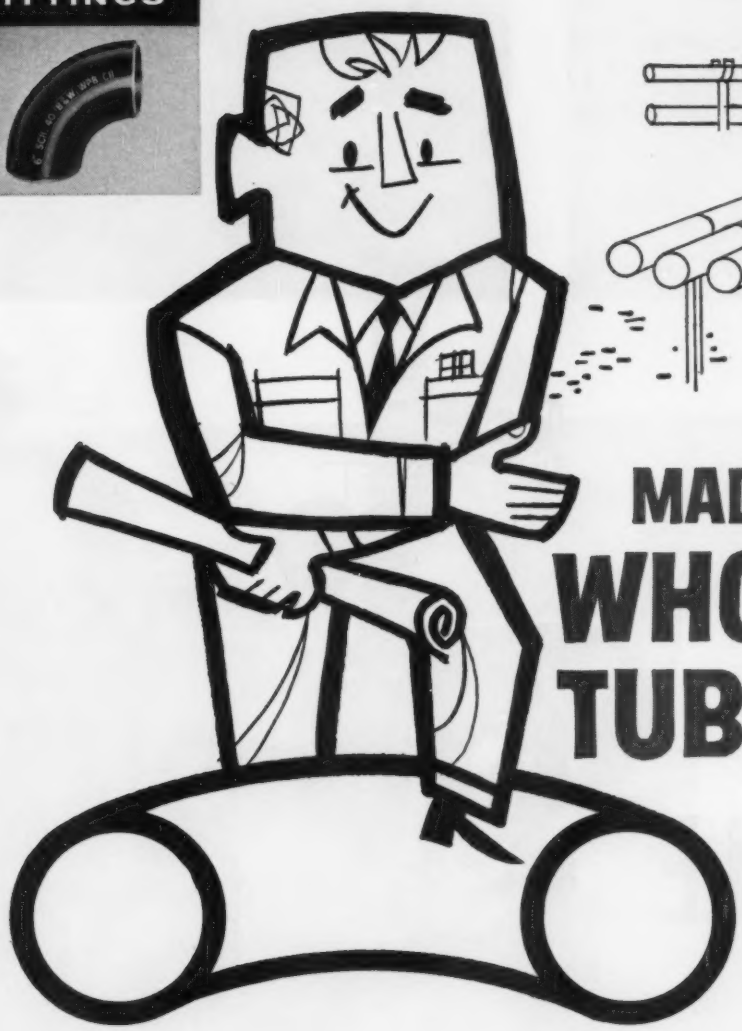
The GC-2A employs a detection system of the thermal conductivity filament type, with fast response, full-flow-cell geometry. The system's sensitivity is 10 to 20 times greater than most filament-type detectors, making



it extremely valuable for trace analysis, even with very small samples such as those used in fast analysis.

Sampling apparatus in the chroma-

B&W
WELDING
FITTINGS



MADE BY MEN WHO KNOW TUBING

B&W Welding Fittings manufacturing is integrated with the Division's own tube-making and steel-making facilities. Consider the relation between tube-making and the manufacture of welding fittings . . . in addition to knowing welding fittings manufacturing, B&W knows of the making of tubing from which fittings are produced. This knowledge plus integration of facilities permits B&W to provide superior fittings, completely quality-controlled, matched to end-use service. It also means on-time deliveries of fittings made from tubing of the specialized steels because B&W can closely control manufacturing schedules from melt to the shipment of the finished product.

B&W Welding Fittings and Flanges are available through qualified distributors in carbon steel and the B&W CROLOYS in a complete range of types and sizes. Write for B&W Bulletin FB502. The Babcock & Wilcox Company, Tubular Products Division, Welding Fittings Plant, P. O. Box 230, Beaver Falls, Pennsylvania.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

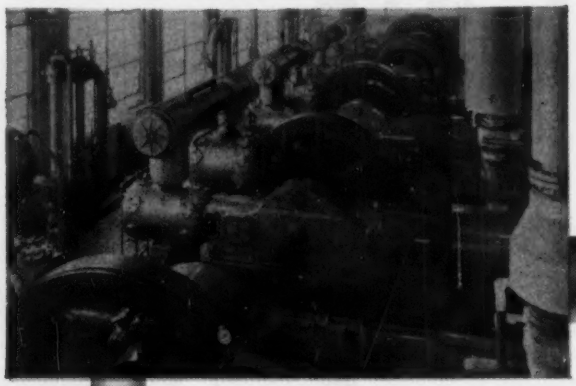
TA-9079-WF2

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

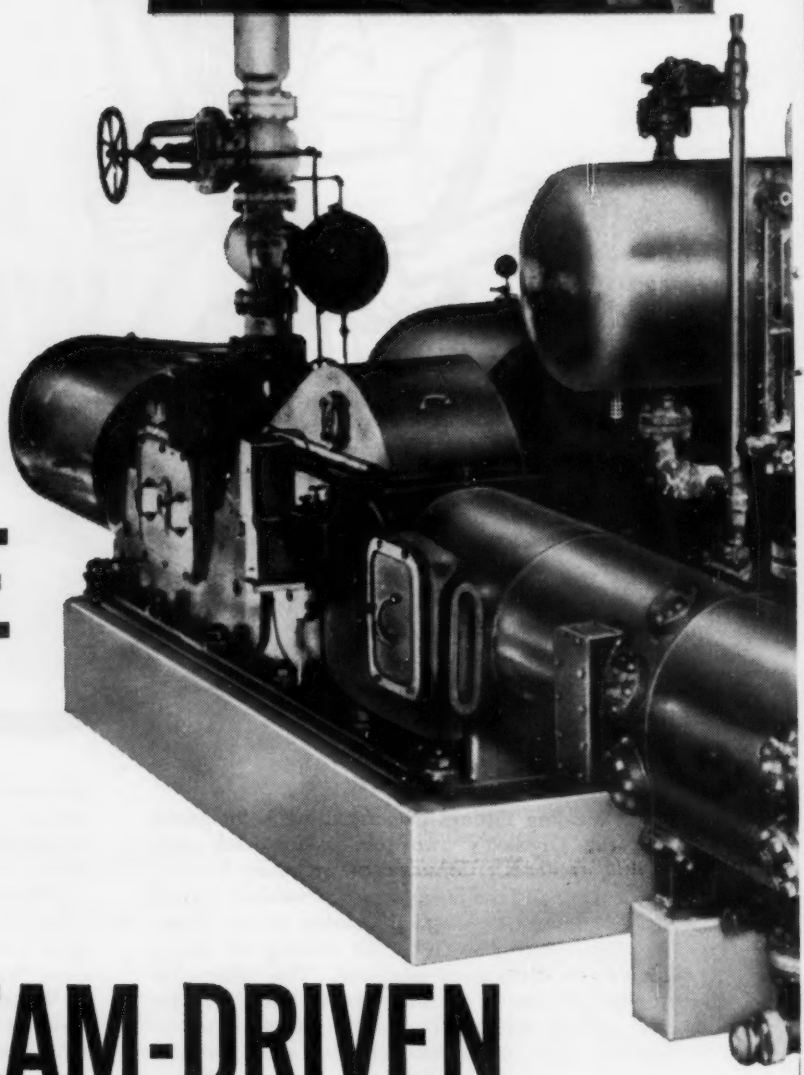
Steam-driven compressors are still preferred where there is a need for exhaust steam for heating or process work, and where it is important to protect against shut-down in the event of electric power failure.

Chicago Pneumatic offers a complete line of steam-driven compressors from 20 to 1250 h.p., and for discharge pressures varying from vacuum to 15,000 p.s.i.g.

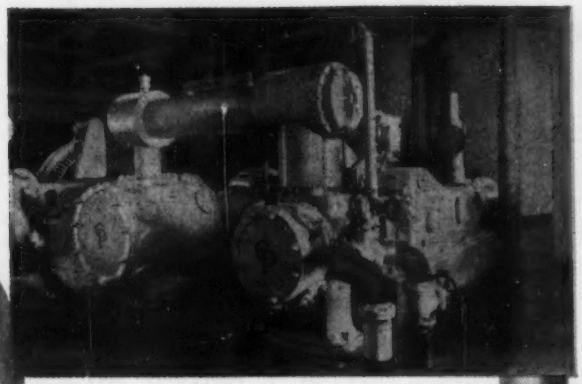
A battery of three Class H steam-driven compressors and two electrically-driven compressors installed in a prominent automobile manufacturing plant.



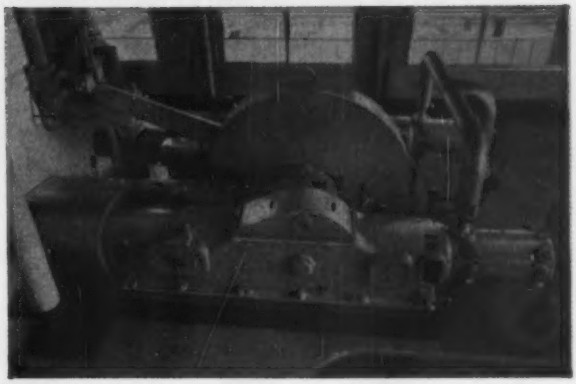
GET FULL VALUE FROM AVAILABLE STEAM... WITH CP STEAM-DRIVEN COMPRESSORS

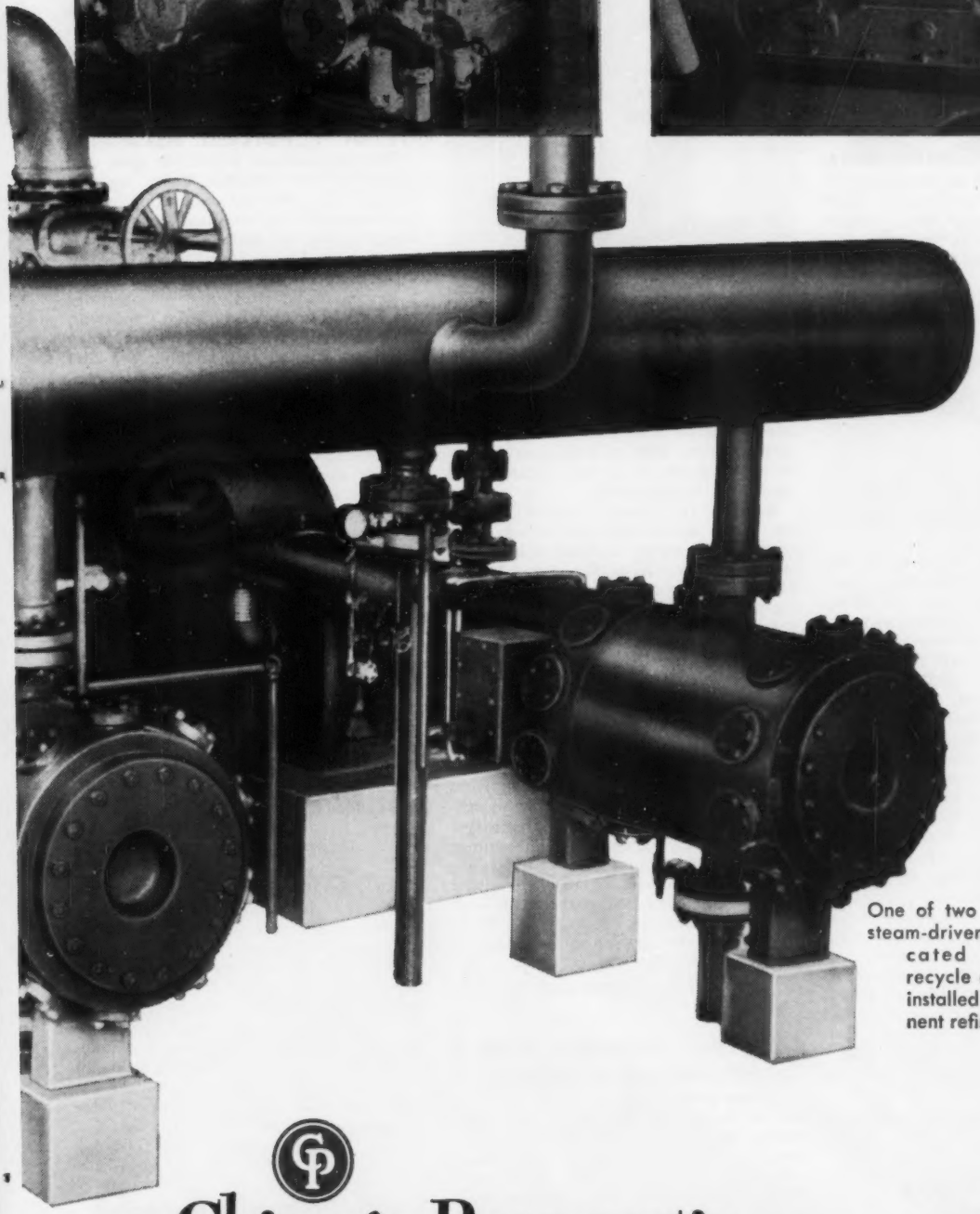


Class H steam-driven compressor with simple steam end furnishing general refinery air.



Class H four-corner, steam-driven, single-stage booster compressor handling hydrocarbon gas.





One of two four-corner, steam-driven, non-lubricated hydrogen recycle compressors installed in a prominent refinery.

Chicago Pneumatic 8 East 44th Street, New York 17, N. Y.

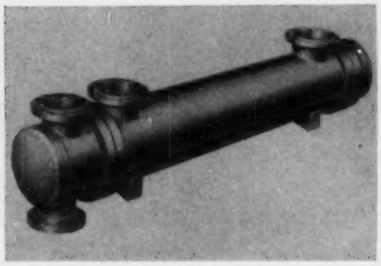
AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

tograph for both the liquids and gases is designed to permit the sample to enter the column as a "plug," thereby maintaining a sharp interface between the carrier gas and the sample. "Plug" sample injection gives a sharp separation of components, minimizing tailing on the peaks. The GC-2-A was designed specifically to balance features of flow control, sampling, columns, and temperature control in such a manner that produces a highly engineered instrument for the broadest possible range of applications. Beckman Instruments, Inc.

Circle E2 green card, last page

Heat Exchanger Formed From Standard Components

The new C-200 line of straight tube, fixed tubesheet heat exchangers, built from standard, pre-engineered components assembled into custom-built units for specific chemical and industrial proc-



essing requirements, is based on the "selective assembly" system that saves substantially in delivery time and offers the user definite cost reductions as compared to conventional tailor-made units.

The C-200 exchanger will handle any combination of liquids and gases and may be used as heaters, coolers, condensers or vaporizers. They are available in shell sizes from 8 through 42 inches and with any practical tube length. Shellside and tubeside design pressures range from 75 to 300 psi with design temperatures for both rated at 400° F. Design temperatures up to 650° F on shell and tubesides are permissible with carbon steel construction, depending on operating conditions.

Tubeside materials are available in Types 304 or 316 stainless steel, cast iron, brass or carbon steel to accommodate a wide variety of fluid chemical properties. Tubesheets are also available in rolled naval brass-clad steel. The tubes may be of any compatible tubing material. The C-200 line conforms with ASME Code and/or TEMA "C" Specifications. American-Standard.

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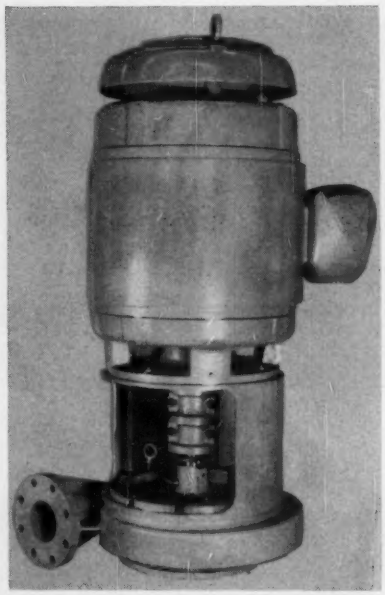
Vertical Pump Allows Inline Installation

The new Vertiplex pump provides rugged, trouble-free operation, and combines minimum installation needs with near perfect accessibility for service or inspection. The complete rotating assem-



bly is easily removed and requires no attention be given to the piping or to the drive motor. Where continuous service is important, it is worth remembering that a complete exchange of pumping element, even with a large pump, may be accomplished in a few minutes and using only simple tools.

A special type spacer coupling between the pump shaft and the motor shaft allows the pumping element to be raised and withdrawn from the pump frame. The drive motor remains in place, and the piping requires no attention. This is a significant advantage when insulation has been applied to the lines.

An installation saving is often possible by mounting the pump directly within the piping system without the need of a separate foundation.

The Vertiplex has been developed to use standard motor speeds up to 3,600 rpm, and offers a capacity range from 100 gpm to over 2,000 gpm with discharge heads up to 300 feet. Steam turbine drive may be applied. The pumps may be furnished in all alloys which are machinable, and can be supplied either with packing or a mechanical shaft seal. Present temperature limitation is 450° F. but higher temperature operation is shortly anticipated. Sempco Corp.

Circle E4 green card, last page

Computer Solution Report To Equilibrium Problems

A nine-page report describes application of the new DYSTAC (R) dynamic storage analog computer to determination of complex chemical equilibrium conditions and composition. These equilibrium evaluations help optimize such variables as feed temperature and operating pressure in chemical process development.

At a given pressure, the report shows, system equilibrium is dictated by heat input to the reactor. At equilibrium, the summation of the heat of reaction and system total enthalpy equals the heat input.

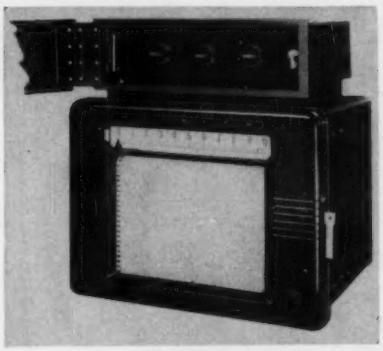
It describes how the computer uses this criterion to establish equilibrium conditions as a function of temperature. The report lists instrumentation required; diagrams complete equipment interconnection for "reactions," "heat balance," and "equilibrium composition"; indicates mathematical derivations and equations; and describes installation and operation of the equipment. Computer Systems, Inc.

Circle E5 green card, last page

Span and Zero Recorder ½ of 1 Percent Accurate

Not just another adjustable span and adjustable zero recorder, but a big step forward. No external calibrating means are necessary. The zero and span settings are on calibrated dials. Span accuracy is an amazing ½ of 1 percent of the set value. Zero settings are accurate to ½ of 1 percent. The span and zero settings can be read at a glance. More important, the two settings mean that an unknown can be measured by changing the dial settings without cumbersome time-consuming calibration. One millivolt span and one second cross chart speed are standard.

The time-tested Zener diode constant voltage source is also standard. This precision source holds the guaranteed accuracy even in the one millivolt span.



There are only three adjustments to be made—the calibrated span vernier, the calibrated zero vernier, and an arbitrary amplifier gain control. The calibrated zero vernier provides any value from 0 to 50 millivolts of suppression for exact settings. The span is continuously adjustable from 1 to 20 millivolts. Zero suppression and span circuits operate independently. After zero is first set, span can be changed without zero shift; conversely, span may be set and zero adjusted without change in span. Barber-Colman Co.

Circle E6 green card, last page

Small System Aftercooler Removes Moisture from Air

Compressed air above 70° F holds moisture in suspension and resists all

HIGH-PRESSURE JETS BLAST DEPOSIT-PACKED BUNDLES CLEAN AS NEW

The high-pressure jet unit below is blasting solidly-caked deposits from a heat exchange bundle . . . removing substantially all traces of deposits throughout the bundle, without cutting it apart!

Nation-wide Dow Industrial Service developed this automatic unit to remove scale, coke and asphalt deposits without metal erosion or wall thinning. This is just one of many advanced tools and techniques developed by Dow Industrial Service to clean equipment of every kind... boilers, pipelines, chemical process equipment, towers, scrubbers.

D. I. S. engineers first analyze your problem, then pick the most effective cleaning method . . . whether chemicals, steam, jet, foam, or other means. D. I. S. tailors the technique to give you most value per dollar.

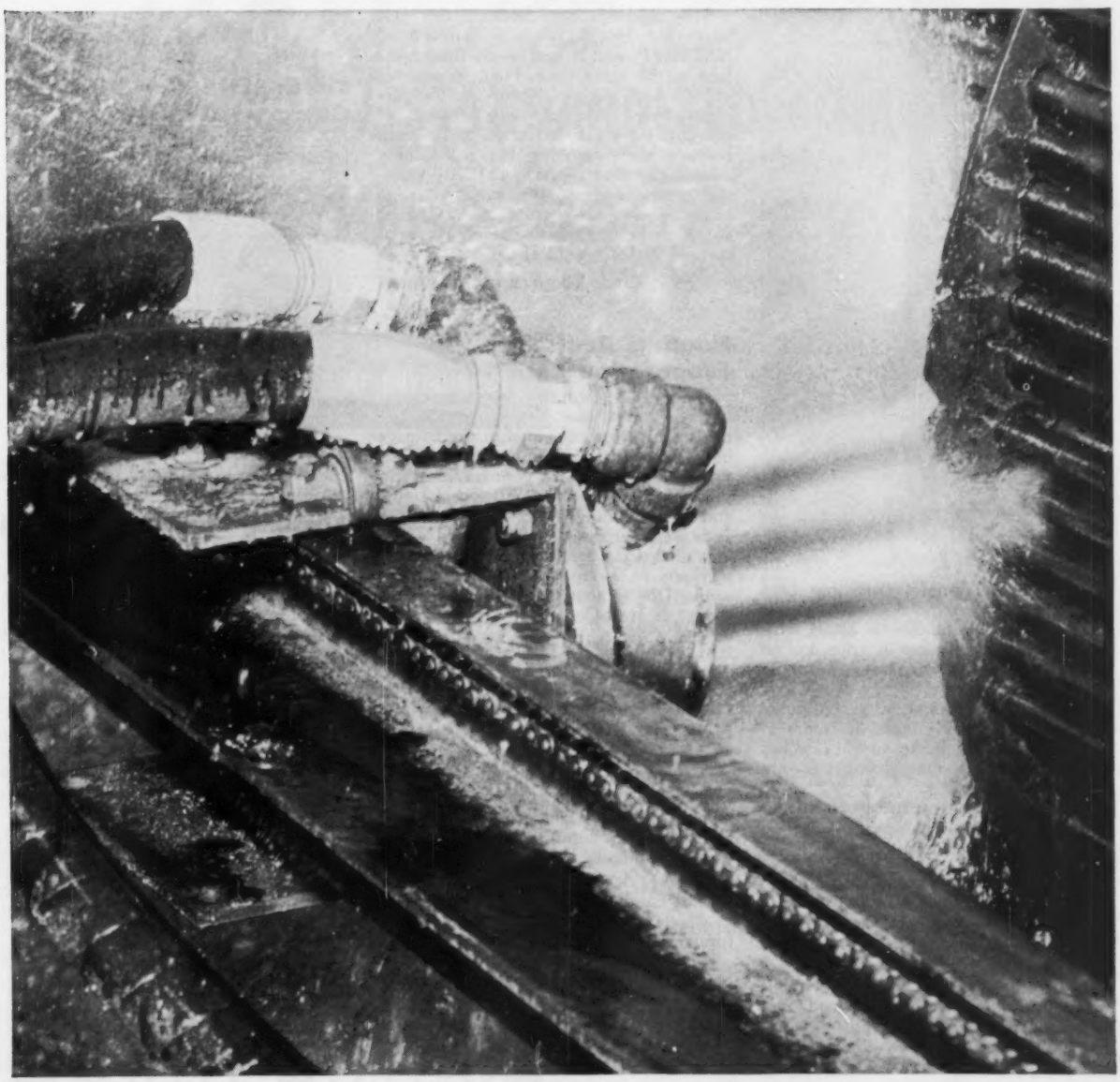
In addition, D. I. S. offers complete consulting laboratory service for water treatment and waste processing problems, backed by the technical resources of The Dow Chemical Company.

D. I. S. is a nation-wide industrial service . . . and offers "total" cleaning. For cleaning equipment of *any* kind, *anywhere*, call D. I. S. We'll be glad to show you how to set up a year 'round cleaning program to *keep* equipment operating at top efficiency. Write or call DOW INDUSTRIAL SERVICE, 20575 Center Ridge Road, Cleveland 16, Ohio.

DOW

Automatic jet unit removes bundle deposits, without dismantling.

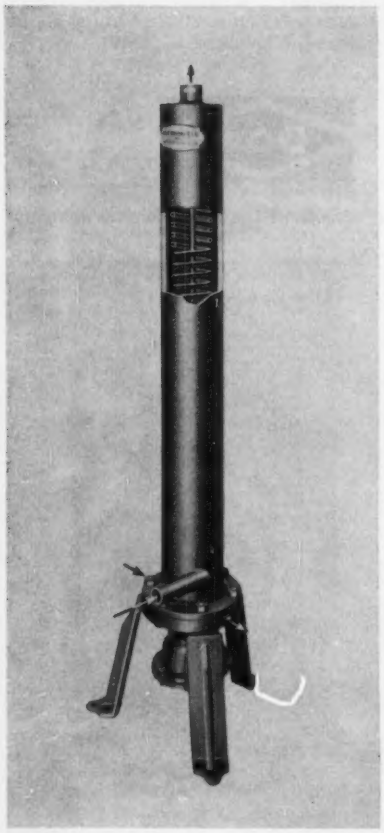
DOW INDUSTRIAL SERVICE • Division of The Dow Chemical Company



For more data on advertised products, use Readers' Service Cards, last page.

means of separation. Cooled, however, it parts with its entrained moisture easily and automatically.

Until now, air-to-water heat exchangers, or aftercoolers, have been designed and produced only for large capacities. Therefore, when hot air became a factor in the operation of small or medium sized



compressed air systems, there has been no convenient remedy.

The A4VC aftercooler is small, efficient, easy to install, low in price, has no moving parts, and requires practically no maintenance.

Built for capacities of 50 to 120 cubic feet of free air per minute, it comes in lengths from 40⅜ inches to 95¼ inches over-all, and the cooling chamber is only 4½ inches in diameter.

It features a non-corrosive copper coil through which the valve-regulated cooling water flows. The coil is attached to the flanged head with flared connections and supported throughout its length by spaced baffle plates which direct the flow of air for utmost contact with the cooling coil. Separated moisture descends by gravity to a ball float trap below where it is ejected automatically and without loss of air. Flanged head and coil may easily be removed as a unit.

Manufacturer guarantees that this unit will cool air to within 85 percent of the cooling water temperature when installed, operated, and maintained according to instructions. Jas. A. Murphy & Co., Inc.

Circle E7 green card, last page

Cooling Water Inhibitor Precleans Surface First

Development of a new concept for effectively controlling corrosion in recirculating cooling water systems is based on a method for initial preparation and protection of metal surfaces of new or freshly-acidized cooling water equipment.

The preparation consists of removal of materials that interfere with corrosion inhibitor film formation such as oils, greases, rust, etc. The surfaces are then kept in an active state at which time a complete, tough protective film is established. The equipment is then said to be protected and will be maintained in this state with the usually employed corrosion inhibitors during normal operation.

The chemical that accomplishes this important initial step is known as NALPREP, and is said to do three vital jobs at the same time. First, it removes organic and inorganic materials and deposits from metal surfaces. Second, it prevents the clean, activated metal from reacting with anything but the filming inhibitor present in the NALPREP material and, third, at the same time, it provides the initial protective film of corrosion inhibitor over the entire metal surface. Nalco Chemical Co.

Circle E8 green card, last page

Floating Roofs Can Cut Evaporation Loss 94%

How proper storage containers for volatile liquids can cut evaporation loss by 94 percent is explained in the 24-page bulletin, "Horton Floating Roofs." Features of double-deck, pontoon and pan types of floating roofs along with metallic and fabric sealing devices are described. It is well illustrated with detailed drawings of floating roof accessories and photographs of Houston structures now in service throughout the world. Chicago Bridge & Iron Co.

Circle E9 green card, last page

High-Alumina Refractory Has Higher Load Strength

A new "XD" process has resulted in an extraordinary high-alumina refractory called Korundal XD. The process lowers the porosity of refractories by as much as 40 percent, diminishing the access of furnace fumes.

The XD development has increased by several hundred degrees the temperature at which furnace walls will show no deformation under load.

Principal features of the new refractory are higher density, lower porosity and higher strength. Besides showing no subsidence in the 3,000° F hot load tests, it displays no spalling loss in the 3,000° F panel spalling test. Spalling is one of the most common causes for decreased life of furnace linings.

Load bearing capacity is illustrated after a load of 25 psi at 3,000° F is held for 100 hours. (This is 67 times the normal duration of the test.) Korundal XD

shows no deformation. However, the same test applied to standard high-quality alumina refractories showed 5.1 percent subsidence (center) and 9.6 percent subsidence (right). Harbison-Walker Refractories Co.

Circle E10 green card, last page

Check Plate Works in Any Gas or Liquid Stream

A check plate has been especially developed to operate in virtually any gas or liquid stream without damage.

The standard check plates are of red brass or aluminum bronze, but can be produced in many metals to the customer's specifications. The plates are being made for any size line up to 24 inches and for pressure differential up to 100 pounds. Tesco, Inc.

Circle E11 green card, last page

Alkaline Cleaner Designed For Really Rugged Jobs

A strongly alkaline cleaner designed for "really rugged" cleaning jobs, is described in Service Bulletin No. 17B.

Designed originally to remove such stubborn soils as burned-on oil, heavy grease and dirt from railroad equipment, RR Cleaner has proved its cleaning power in many other applications. It may be used in the cleaning tank or in steam cleaning operations. It may be used with safety on steel, iron, brass magnesium, and other metals, but is not recommended for aluminum or zinc. Solutions of the compound clean fast, and have long life in the tank. They may be mixed with solvent detergents to remove certain soils, such as asphalt, which resist straight alkaline solutions. Oakite Products, Inc.

Circle E12 green card, last page

Ductile Iron Valves Strong as Carbon Steel

A two-color, 12-page catalog gives

NEW

G-R *Pre-Engineered* STANDARDIZED COMPONENT SHELL and TUBE *Heat Exchangers*

Outstanding Purchaser Advantages:

1. Proven construction reflecting many years experience in designing and fabricating custom shell and tube exchangers for the Petroleum, Petrochemical, Chemical and allied industries.

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9. Adequate inventories and partial pre-fabrication speed delivery.

10. Full compliance with ASME and TEMA-R Codes, whichever is most exacting, plus G-R quality control.

11. Wide range of shell sizes, surfaces, and pressures to meet all but the most unusual requirements.

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complete details on designs, weights and dimensions of the company's ductile iron valves and fittings. Also included are comparison charts, engineering specifications, and information on prices, terms and deliveries.

Of particular interest to valve users is the section dealing with comparisons between ductile iron and other materials.

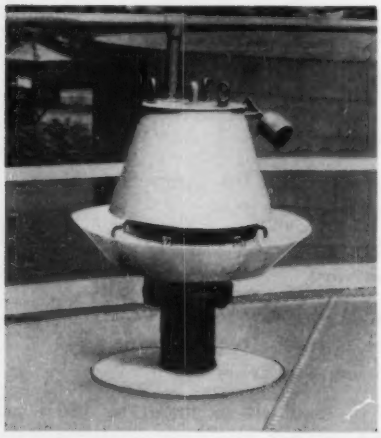
According to company engineers, "Corrosion resistance is equal to gray iron and several times that of carbon steel. In fact, ductile iron offers the properties that metallurgists and engineers have been seeking for years. It combines the strength, toughness and impact resistance of steel with the corrosion resistance of grey iron." Stockham Valves & Fittings.

Circle E13 green card, last page

Storage Tank Vapors Vented by Relief Diffuser

Fumes and gases vented from the storage tank, as product is pumped in, are directed high into the air by the new vapor inverter, protecting personnel working on surrounding tank roofs and nearby ground areas from exposure to poisonous fumes. It is a valuable aid in air pollution control.

The inverters do not impair the flow capacity of relief vents on which they are mounted, and are designed and tested for efficient operation even under snow



and freezing conditions. The inverters diffuse snow, and the bottom holes facilitate rapid drainage of water. Gases and fumes, 80 percent or more vented from the storage tank are directed up into the air, by the inverter, at velocities ranging from 13 to 25 miles per hour.

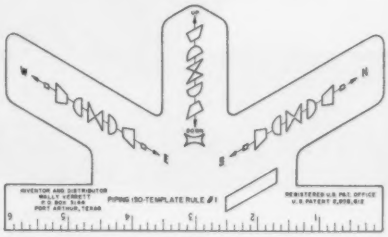
It is available in 2, 3, 4, 6, 8, 10 and 12-inch sizes, to fit any size, of any relief vent, made by any manufacturer. The Johnston & Jennings Co.

Circle E14 green card, last page

Isometric Piping Template Simplifies Piping Layout

A new template designed for isometric pipe drawings enables standardized isometric drawings to be made of all pipe layout sketches.

Because of its simplicity, even beginners can make professional drawings the first time. Features include: pocket size, cut-outs for most common fittings sym-

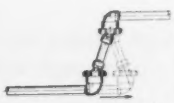


bols, laminated clear plastic, rounded corners for uniform angles, and handy compass orientation points. Engineers, operators, pipe sketches, detailers, draftsmen and designers would find this tool a very welcomed addition to their drawing boards. Wally Verrett.

Circle E15 green card, last page

Ball Joint Valves Answer Pipe Expansion Problems

How to easily provide for movement and flexibility in metal piping with simple ball joints is detailed in a new eight-section catalog.



Illustrations of the five basic motion principles of ball joints serve as the key to the numerous examples of how to provide safe flexibility in piping subject to contraction and expansion. Actual installations are also shown and explained. Sections of the catalog cover ball joints in sizes from ¼ through 16 inches with threaded, flanged or welding end connections and joints for high temperatures (up to 1,000° F) and pressures. Barco Mfg. Co.

Circle E16 green card, last page

Pneumatic Tube Roller Can Roll 12 Tubes Per Minute

A new, high-speed adaptation of the company's pneumatic tube expansion control for use in up to and including ¾-inch steel or non-ferrous tubes is lighter in weight than the standard control and features a quick reversing handle.

Tubes can be rolled at the rate of 12 per minute, or better, with the Model 900 Airetrol, to uniform accuracy of within .001 of an inch. It automatically stops expansion according to a predetermined dial torque setting. This extreme accuracy results in uniformly tight tube joints, and there is no under or over expansion.

The Airetrol's motor and torque sec-

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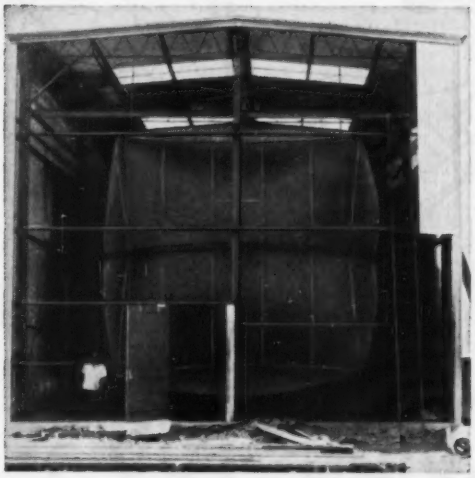

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Plidcoflange slips over end of pipe, mates up with standard flange facings. No flange spreaders, jacks or bars required. Ideal for use as a blind plate flange. Just slide Plidcoflange back to change plates.

Plidcoflanges are available in standard sizes 2″ through 12″ with 150 lb. A.S.A. steel flanges. Other sizes and pressure classes on request. Send for illustrated brochure.

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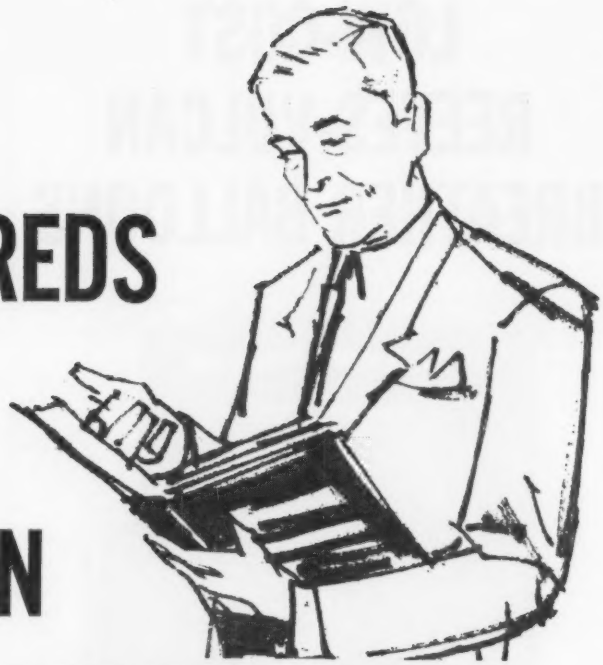

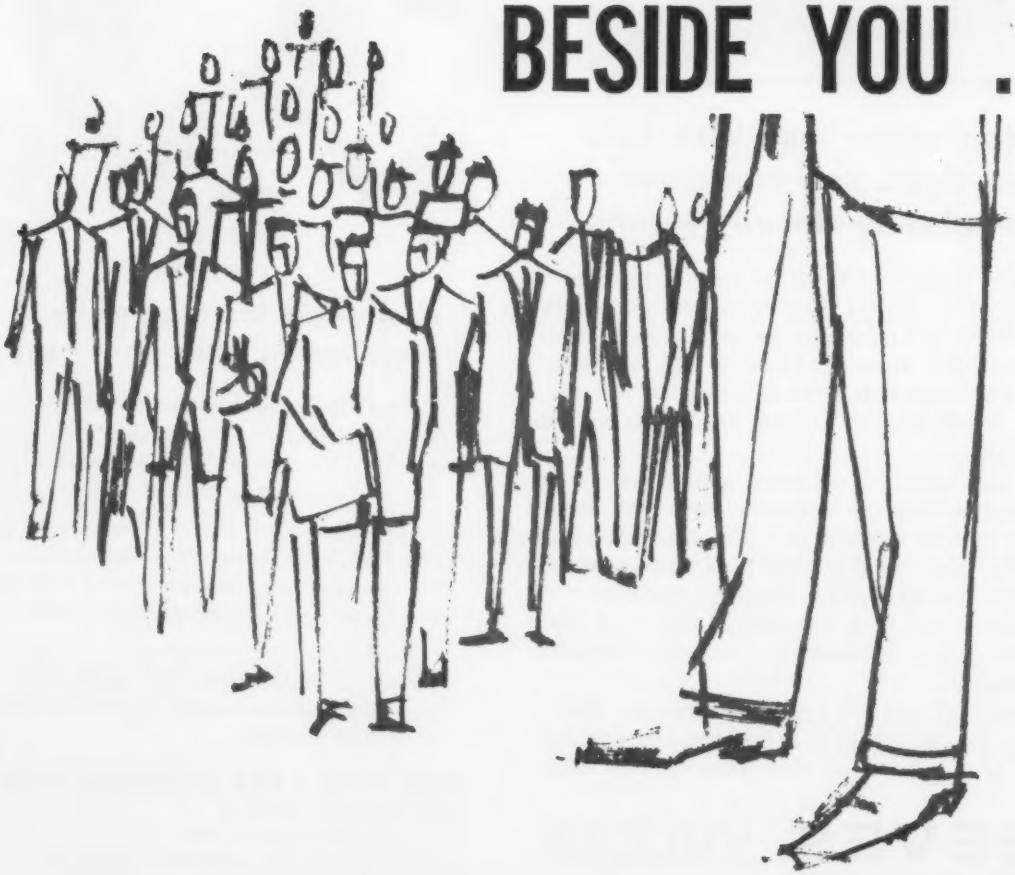

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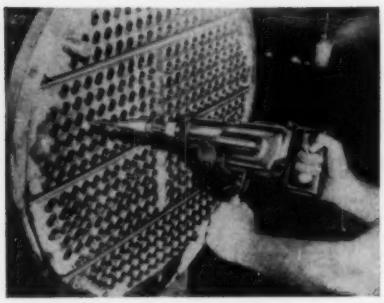


mechanism will withstand rough handling, assuring trouble-free service. The Airetool Mfg. Co.

Circle E17 green card, last page

Surface Heaters Handle Heavy Viscous Products

A 44-page technical data catalog gives detailed information and engineering data on Isomantle Surface Heaters for vessels, pipe lines, valves and storage facilities in processing operations handling heavy or viscous products. The data book gives information on both standard units constructed to specifications and the new flame-proof units now available for hazardous areas.

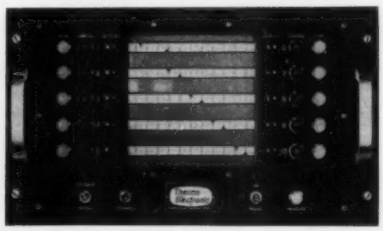
Data are also shown on the combination electric and/or steam-heated units in both standard sizes or custom sizes and design. The specifications include complete wiring diagrams and charts in graph form showing requirements under various operational conditions. Isopad, Ltd.

Circle E18 green card, last page

Multi-Point Controller Checks on 10 Processes

A new multi-point temperature controller provides accurate automatic two-position control for up to 10 separate processes. It saves initial investment, panel space, and cuts installation, operation and maintenance time.

The instrument can also be used as a single-point controller, a five-point, three-position controller and a manual-balance indicator. Any points not being used for control of a multiple-temperature process, can monitor other processes.



The controller combines a sensitive null-balance potentiometer measuring circuit with an electronic control system. It is adaptable to any installation requiring off-on control. Accuracy is 0.5 percent of range. Thermo Electric Co., Inc.

Circle E19 green card, last page

Plastic Pipe Good For 600 psi and 140° C

A 52-page engineering databook catalog gives information on the epoch pipe system now available in 6, 8, 12 and 15¼-inch sizes and for operating pressures up to as high as 600 pounds for the 6-inch pipe. The system includes a complete line of fittings, including flange adaptors. The manufacturers say that this pipe is virtually unaffected by salt water and the majority of dilute acids and alkalis even up to temperatures of 140° C. The bore of the pipe is mirror-smooth and while as strong as steel, the pipe is far more flexible than the equivalent steel pressure pipes. Bristol Aeroplane Plastics, Ltd.

Circle E20 green card, last page

Instrument Plug Valves Covered in Bulletin

A new bulletin, covering compact Figures 22 and 30 Tufline screwed end plug valves for instrument and process piping, contains photographs and exploded views

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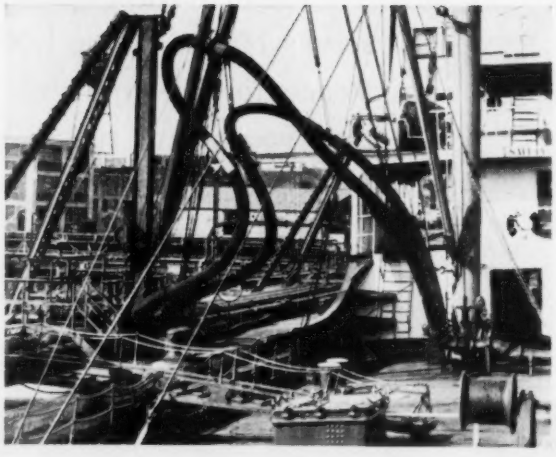

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RM 107

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of the valves' components. It shows how they provide bubble-tight closure in on-off service, plus corrosion resistance, absence of product contamination, and ease of operation.

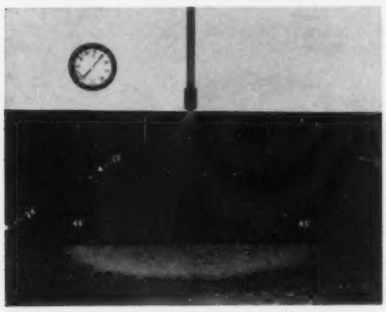
Tables giving dimensions of the various Figure 22 valves from ¼ to 1 inch and the Figure 30 valves from ¼ to ½ inch are also included.

In addition, drawings and photos show how these valves may be used in different applications. Continental Mfg. Co.

Circle E21 green card, last page

Atomizing Nozzle Produces Very Fine Cone Mist

A new Figure 661-S atomizing nozzle which produces a very fine, uniformly-atomized, solid-cone mist in capacities as high as 330 gph is available from stock



in bronze and stainless steel, in orifice sizes from 2.0 to 6.0 mm. Special corrosion-resistant materials are also available on request. Schutte and Koerting Co.

Circle E22 green card, last page

Cost of Stuffing Box Leakage Shown on Chart

A new brochure "Profits Down the Drain" showing money lost from stuffing box leakage illustrates daily and yearly leakage costs based on the value of the liquid metered.

Costs of pressure flushing, drainage, contamination, maintenance, and loss of accuracy resulting from such leakage are discussed. Methods of overcoming these problems are suggested. Data on metering units with leak-proof design is included. Lapp Insulator Co.

Circle E23 green card, last page

Pipe Alignment Guide Has Clearance for Insulation

A new pipe alignment guide consists of a cast steel segmented spider, sized to the OD of pipe from ¾ to 24 inches nominal size, free to move axially in a segmented steel cylinder. The spider is clamped to the pipe, and the guiding cylinder is securely fixed to the supporting structure. The spider provides clearance for complete insulation through the guide.

Also new, roller pipe supports are finding wide application even where expansion joints are not used. They are constructed entirely of steel. A formed steel spacer is provided for welding to the pipe. This spacer provides clearance for insulation, provides better support by increasing the bearing area, and relieves

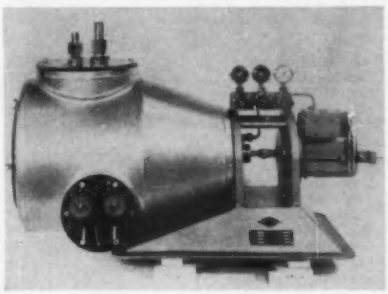
the pipe of direct contact with the steel roller. The units are available for pipe sizes ¾ to 14 inches, with larger sizes available on special order.

The alignment guides and roller pipe supports are dimensioned to provide the same center line distance from the mounting surface, size for size. This feature simplifies the fabrication of orderly installations. Flexonics Corp.

Circle E24 green card, last page

Cryogenic Pump Requires Minimum Suction Head

A new hydraulically driven, high-pressure, reciprocating cryogenic pump requiring a minimum suction head is



suitable for stationary or truck-mounted installations. Sizes available range from 5,000 scfh up to 30,000 scfh. American Messer Corp.

Circle E25 green card, last page

Bulletin Describes Valve For Liquid Level Uses

A new bulletin furnishes data on the reliance type LV-10 lever-actuated control valve for liquid level applications. With a maximum inlet pressure of 400 psi, the valve is equipped for sensitive operation and minimum maintenance.

Details of the unit's balanced valve and low-friction rotary seal are clearly shown in cutaway illustrations. Complete dimensions are given in tables and diagrams. American Meter Co.

Circle E26 green card, last page

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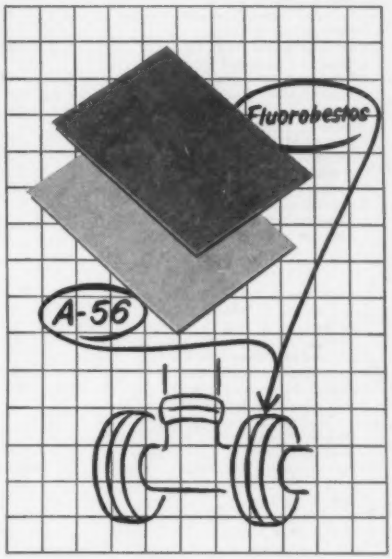
Develops these outstanding gasket materials



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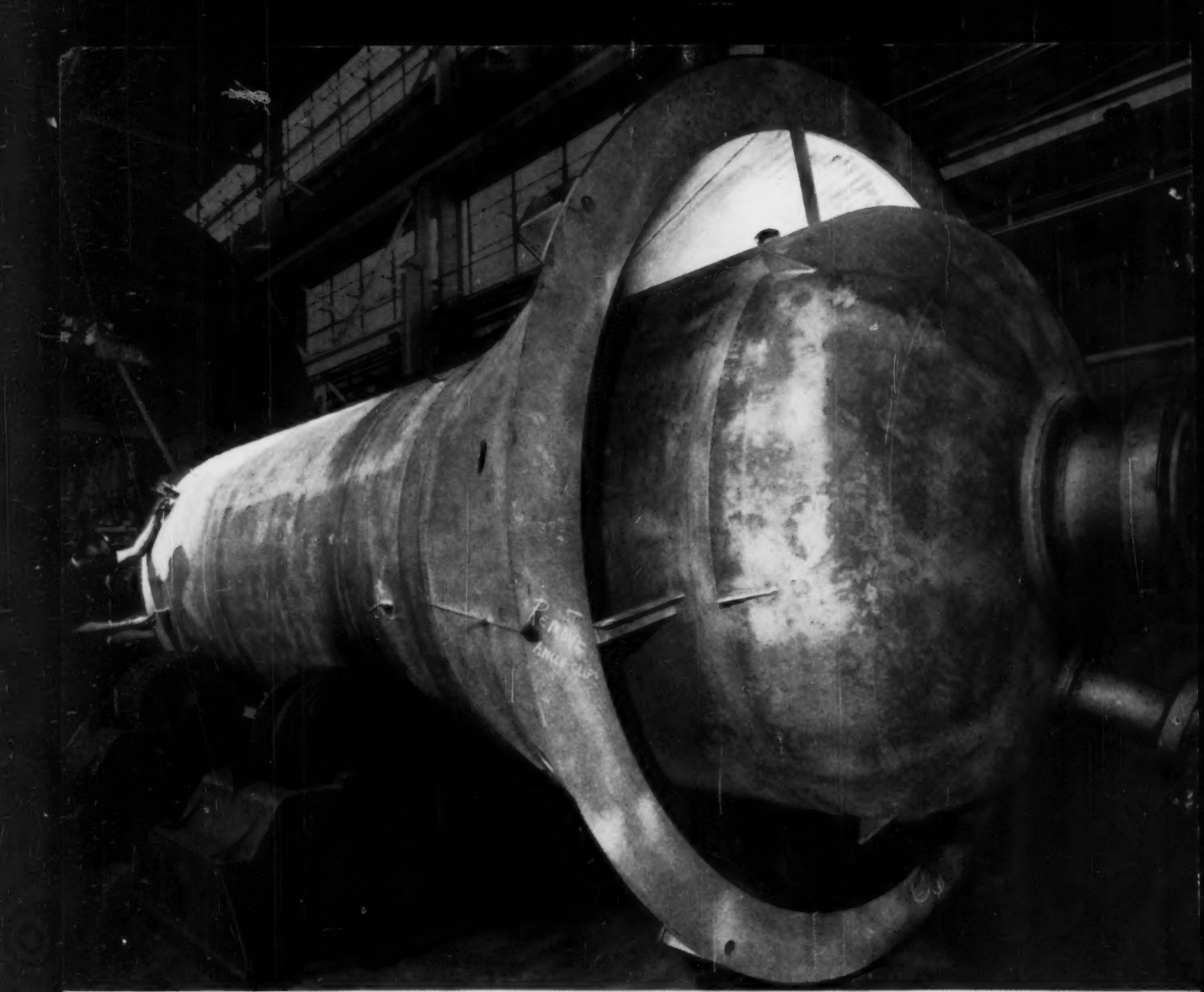

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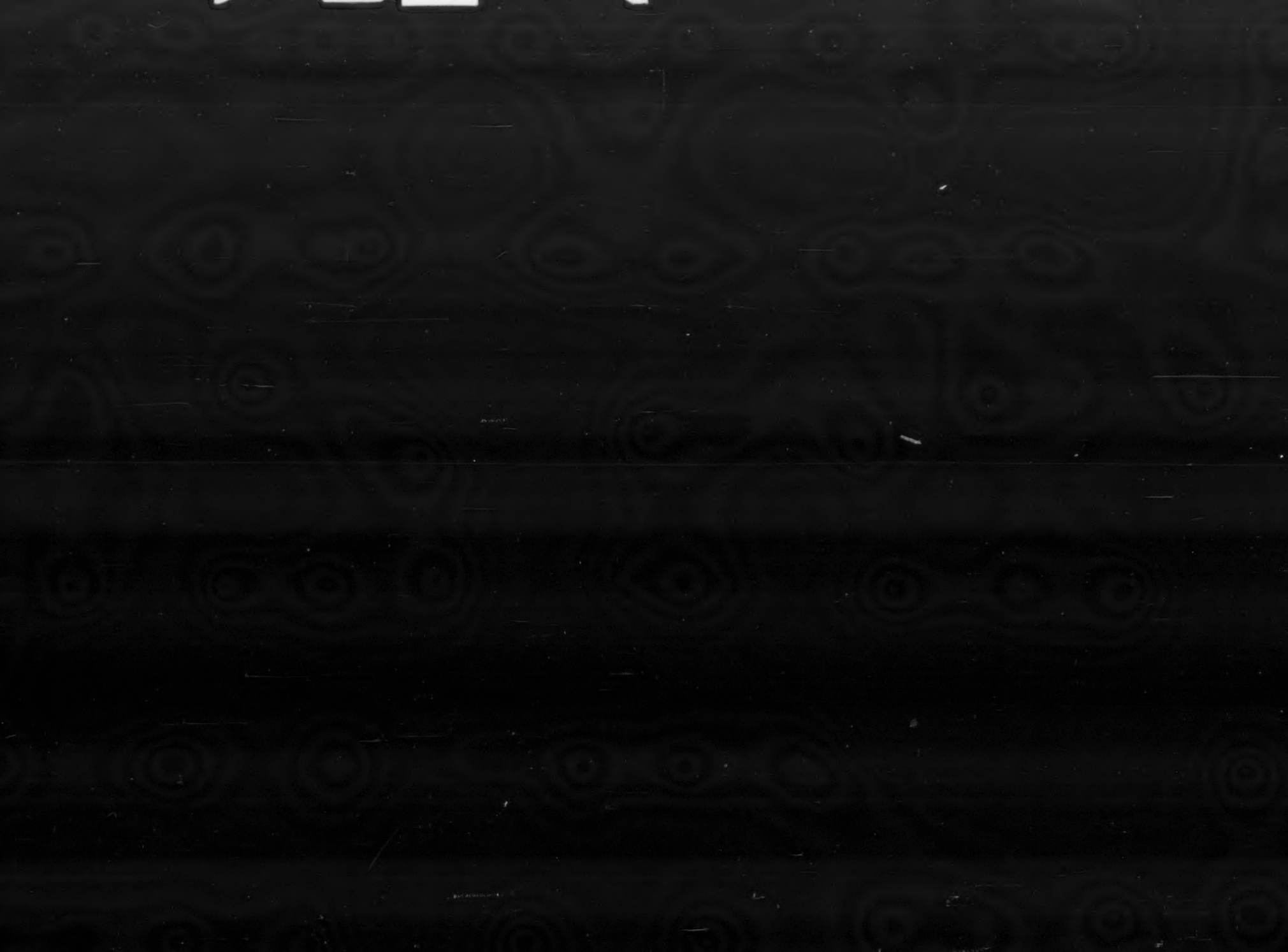
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